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The decision to burn or harvest cane green?

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In the South African sugar industry up to 80% of cane fields in dry land areas and more than 95% of the fields in irrigated areas are burnt before harvest. Sociological pressure is building up near cities and towns to stop all burning within a buffer radius of 5 km. Environmental pressures are also increasing to reduce burning before harvest. Additionally, burnt cane left standing in the field can deteriorate rapidly before delivery to the mill and may seriously affect the quality of raw sugar produced and even the quality of refined sugar and products where refined sugar is used.

Sugarcane growers in South Africa need to be convinced that they can produce similar or higher income per hectare from green cane harvesting compared with burning before harvest. One way of persuading growers to reduce burning is through legal action but then only as a last resort. A more acceptable strategy is to let growers decide themselves on economic grounds whether to burn or to harvest green cane and or where (which fields) not to trash.

To this end, a simple decision support programme (DSP) has been developed at SASEX for use as an extension tool to help growers decide whether it is economical for them to burn or to harvest green cane. Inputs required are the cost to cut, stack and haul, transport cost, distance to the mill, value of cane, increased yield due to trashing, savings on labour and herbicides, crop age and fertilizer costs as affected by trashing. Resulting outputs from this DSP include the potential savings and costs associated with green cane harvesting and trashing. Various scenarios are presented to illustrate the use of the DSP.

Keywords: Sugarcane, burning, green cane harvesting, economics, computer programme.

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Green cane harvesting and soil nutrient management in Brazil

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Like many other cane producing countries, in Brazil most of the extraneous leaf material from sugarcane stalks is burned off before harvest, producing smoke and some protests from citizens living in cane growing areas. It has been suggested that the removal of the cane trash by pre-harvest burning causes losses of nutrients (particularly N) from the cropping system. Besides that, N fertilizer applications on sugarcane are modest; ranging from 0 to 60 kg/ha of N on plant cane to 60 and 120 kg/ha of N on ratoon crops.

Recent data comparing sugarcane fresh trash that remains on the soil surface shows that there was a reduction of mass of approximately 30% across the year. The release of N, P, K, Ca, Mg and S, in relation to the total amount of nutrients in the fresh trash was 18, 67, 93, 57, 68 and 68%, respectively. Based on this study, potassium fertilizer is being reduced almost 30% by some sugarcane growers.

Some of the advantages of trash preservation on the soil (green-harvest) in the sugarcane crop system in Brazil are: the partial or even total elimination of the use of herbicides in the ratoon crops by weed suppression, increase yield under conditions with marginal moisture (conservation of soil moisture), protection of the soil against erosion and high temperatures, decrease run off and increase infiltration of soil water, increase organic matter and recycled nutrients, and improved sugar recovery in the sugar-mill. Disadvantages are also associated with green-cane harvest: reluctance of field workers to cut cane when trash is not removed, reduced manual and mechanical harvesting and loading rates, increased damage to the ratoon crop and reduce tillering where combine harvesters are used, and trashing increases the risk of pests (Mahanarva posticata and M. fimbriolata).

Keywords: Sugarcane, fertilizer rates, residue management, trash management.

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Simulated benefits of trashing in the South African sugar industry

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Many trashing trials have been conducted in the South African sugar industry to assess the effects of trashing on soil nutrient availability, fertilizer policies, water retention, and yield responses. However, these trials were conducted near the coast on a group

of soils with similar physical properties. In order to address the problem of using information from these trials and to extrapolate them to the rest of the sugar industry the APSIM crop model was used. The model was first validated against data from a 60-year old burning and trashing trial (BT1). Secondly, computer files for four soils found commonly in the industry and meteorological information for eight areas scattered over the industry were compiled for use with the APSIM model. The soils included one well drained, one very high in clay content and two with a duplex character. The results were surprising as to the effect of altitude on trashing suggesting even improved yields on crops cut in a two-year cycle. In dryland areas the main simulated effect of trashing was to reduce runoff leading to more water available for crop growth resulting in improved yields. Under irrigation no yield improvement was simulated but the yield level was maintained although less water was used.

Keywords: APSIM, cane trash, cane yield, soil carbon, soil nitrogen, sugarcane.

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Opportunities for gaining carbon credits in the South African industry

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The international scientific community has recognized the potential negative impact of greenhouse gas accumulation on world climate and in this regard temperatures of up to several degrees warmer are likely in the next 50 years, and effective rainfall along the eastern seaboard of South Africa is expected to decrease. While global climatic change presents golden opportunities to use sugarcane as a biofuel to substitute fossil fuel reserves in the form of electricity generation and the production of ethanol, there are other less publicized opportunities for gaining carbon credits from sugarcane field operations.

Sugarcane operations that contribute negatively either directly or indirectly to climate change in term of mainly CO_2 production and to a lesser extent other greenhouse gas emissions include soil cultivation, burning of sugarcane prior to harvest, the use of fertilizers and other chemicals that require fossil fuel in their manufacture, fossil fuel used in various field mechanized operations and in the milling and refinery process. When soils are cultivated some of the carbon stored in them is gradually released to the atmosphere. Historically and taken in the global context, this process has contributed about half of the observed CO_2 increase in the atmosphere to date, although in current day terms soil disturbance effects have been minimized through minimum tillage and is responsible for one fifth or less of the annual rise.

Although the practice of burning cane prior to harvest is regarded as "climatically neutral" in terms of CO_2 which was derived from the atmosphere anyway, the emission of smoke and trace gases such as methane, nitric oxides and unburnt hydrocarbons makes this practice not climatically neutral. Methane is 20 times more powerful than CO_2 on a mass basis while nitric oxide is 100 times more powerful than CO_2in its effect on the environment.

Currently about 80% of the cane grown in South Africa is burned prior to harvest. While there are sound agronomic and economic benefits for reverting to green cane harvesting over a wide area in terms of improved yields, soil conservation and reduced weed control costs, there is also the added economic incentive of saving carbon credits and recovering funds through the Clean Development Mechanism (CDM) for developing countries, that formed part of the United Nations Kyoto Protocol agreement on Climatic Change. Preliminary calculations indicate that the elimination of burning in South African cane fields would have the equivalent effect of avoiding the emission of 600,000 tonnes of CO_2 annually. This savings in carbon can be traded on exchanges in Chicago or London and currently the economic value amounts to about $20 per tonne of CO_2 equivalent. The economic impact industry-wide could run into several million dollars from eliminating burning alone. Other factors such as savings in carbon by using minimum tillage and co-generation could increase the impact even further.

Keywords: Burning, carbon credits, global change, green cane harvesting, greenhouse gas.

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Genotypic differences in nitrogen use efficiency and implications for N fertiliser management in the South African sugar industry

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Historically, N fertilizer recommendations for sugarcane in the South African sugar industry have been based on the requirements of the variety NCo 376 and an estimate of the N mineralising potential of soil. Studies in assessing the N use characteristics of hydroponically grown sugarcane varieties have indicated that there may be exploitable genotypic differences in N-use efficiency for a range of commercial South African varieties. High N-use efficiencies (based on g sucrose g-1 accumulated N) were recorded for varieties N12, N19 and N25, which were 65%, 63% and 45% above the reference variety NCo 376. Varieties such as N16, N24, N27 and N31 were within 20 % of the reference variety NCo 376 and rated as moderately N-use efficient. In contrast, N14 was found to be 19 % less efficient than NCo 376. Available field trial evidence supported the results obtained from the hydroponic screening technique. An irrigated N by variety trial confirmed that varieties N24 and N14 both showed significantly higher N requirements than N19 and N22. These data suggested that substantial benefits might be derived from variety - specific N fertilizer recommendations for sugarcane, rather than a single recommendation based on NCo 376. Current fertilizer recommendations for N14 have recently been increased by 30 kg N ha-1, based on field trial data, and N recommendations for N12 and N19 will be reduced by 20 kg ha-1. The hydroponic technique should be useful for initial screening of commercial and new sugarcane varieties before final field-testing and amendments to fertilizer recommendations.

Keywords: Fertilizer, N-use efficiency, screening, varieties.

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Nitrogen demand curves as a tool for scheduling fertigation for drip-irrigated sugarcane

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Between 1998 and 2002, the combined area of sugarcane under drip irrigation in the Swaziland and South African sugar industries grew from 9,000 to 15,000 ha. The increasing popularity of drip provides the opportunity for improving fertiliser management via fertigation, and researchers in Mauritius and Australia have recorded associated increases in fertiliser efficiency by using this system. In southern Africa fertilisers are normally applied in dry solid form during the early stages of crop development and watered in by the next irrigation cycle. With fertigation, applications of water and soluble fertiliser are simultaneous, establishing the opportunity to fertilise the crop at any stage of development provided there is adequate demand for irrigation. In particular, soluble nitrogenous fertiliser can be applied to coincide with the predicted nitrogen demand of the crop, thereby reducing potential for losses to the environment.

In a joint project between the Swaziland and South African sugar industries, predictive nitrogen demand curves were derived for sugarcane from the results of irrigated growth analysis lysimeter trials. The results of these trials showed that a crop harvested in November accumulated 80% of total above ground nitrogen during the first four months of growth, whilst a crop harvested in April accumulated only 15% of total above ground nitrogen over the same time period. Monthly nitrogen demand curves for summer- and winter-harvested crops were then tested against more simplistic fertigation strategies in a series of replicated, drip-irrigated experiments in Swaziland. Results indicated that the winter nitrogen demand curve correctly predicted the requirements of a winter ratoon crop but did not account for the effect of late nitrogen application on cane quality. The summer nitrogen demand curve appeared to underestimate the requirements of a summer plant crop between January and April. Dividing nitrogen applications evenly over the first four months of crop development led to more efficient and productive use of nitrogen than the nitrogen demand curve approach, but apparent losses of fertiliser were probably affected by the timing of heavy summer rainfall in relation to the timing and quantities of nitrogen splits in each treatment.

Although possible in drip-irrigated sugarcane, complex nitrogen splitting strategies based strictly on predicted nitrogen demand may not be practical in a high summer rainfall environment. Under the climatic conditions of the southern African lowveld, the true value of fertigation with drip irrigation may lie in the flexibility of the system, enabling growers to apply fertiliser tactically in response to predicted or measured nitrogen losses, as well as strategically to meet periods of high demand.

Keywords: Southern Africa, nitrogen splitting, fertiliser efficiency.

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Monitoring nitrogen at the mill

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Australian sugarcane growers rely on N fertilisers to ensure farm profitability. The lack of a rapid and cost effective means of monitoring crop N status has led to growers applying N in excess of crop requirements as an insurance against the yield reductions associated with applying insufficient N. A system that monitors N in sugarcane supplied to the mill will represent a simple means of providing growers with information on the N status of their crops in addition to routine block data.

Sugarcane juice and millable stems were sampled from N by variety trials and sugarcane mills in Queensland between 1996 and 2002. High Pressure Liquid Chromatography (HPLC), ninhydrin assays, and total N assays were conducted to determine the form and pool sizes of stem N and to determine the response of these N pools to N supply. Rapid in-line means of measuring cane N using near infrared spectroscopy (NIR) were investigated.

Stem N was shown to be sensitive to N supply and the stem N pools were found to be mainly in the extracted juice, where they were present as amino acids, in particular asparagine. Diagnostic curves of juice amino-N versus relative sugar yield separated sugarcane crops into three crop N status groups: "Low range" (<150 µg amino-N/ml juice), "Target range" (150-250 µg amino-N/ml juice), and "Excess range" (>250 µg amino-N/ml juice). Monitoring of sugar mills in Queensland showed that over 50% of cane supplied was in the "excess range" of crop N status. Feedback of laboratory-determined amino-N to growers resulted in altered N fertilisation practices. Developmental work on an NIR calibration for amino-N is showing promise with work continuing.

The monitoring of N in stems or juice of sugarcane supplied to the mill via NIR represents a rapid, cost effective means of determining the N status of all cane grown in a mill region. Feeding this information back to the grower will enable growers to alter N fertilisation practices to maintain yields while minimizing N losses.

Keywords: Amino acids, ninhydrin, crop N status, NIR.

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Potassium split fertilization on plant cane

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The application of high levels of potassium (potassium chloride) to relatively narrow bands in the furrow can reduce sugarcane yields by increasing salt root damage and potassium leaching. A field experiment was carried out in an Acrustox from Guaira Sugar-mill (Sao Paulo State), during the year 1992/1993 with the objective of evaluating the use of split applications of potassium on plant cane compared to the furrow application of potassium. Treatments consisted of four potassium rates (0, 60, 120 and 180 kg/ha of

K2O) applied in the furrow and three split applications of 120 kg/ha of K2O (30 kg/ha in the furrow and 90 kg/ha applied after covering as a side-dressing, 60 kg/ha in the furrow and 60 kg/ha applied after covering as a side-dressing, and 90 kg/ha in the furrow and 30 kg/ha applied after covering as a side-dressing, and 120 kg/ha applied after covering as a side-dressing). Sugarcane yield, exchangeable potassium in the soil and sugar content were the main response variables studied. The experimental design was a randomized complete block with eight treatments and three replications. Sugarcane yield increased with potassium rates and by splitting the applications. Yield increased by more than 9% with the 120 kg/ha K2O split application strategy of 60 kg/ha in the furrow and 60 kg/ha during covering ("side dressing" or "break loin" operation). Sugar content was not affected by treatments. Exchangeable K increased in the soil depth with the potassium fertilizer rates. It was observed that K was leached in the soil profile. This information could be used to explain the beneficial effects of splitting potassium in plant cane.

Keywords: Sugarcane, potassium chloride.

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Management of legume residues to maximise the nitrogen benefits to the following sugarcane crop

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Breaking the sugarcane monoculture with a fallow legume can have important effects on the yield of subsequent sugarcane crops. Yield increases following fallow legumes have been attributed to both improvements in soil health and benefits provided through symbiotically fixed nitrogen. In recent studies it has been shown that the benefits of legume nitrogen for the following sugarcane crop can be influenced by how the legume residue is managed. We have shown in studies in Australia that the traditional method of green manuring, which involves ploughing the green legume residue into the soil, can promote rapid mineralisation of nitrogen. Under conditions of high rainfall and permeable soils this results in substantial losses of nitrogen through leaching. We have demonstrated that under such conditions it is better to leave the legume on the soil surface, either as a standing crop or surface mulch. This legume residue management strategy results in slower mineralisation rates and substantially increases available legume nitrogen for the following sugarcane crop.

Keywords: Green manure, nitrogen fixation, standing residue, surface mulch.

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An innovative approach to sustainable nutrient management in the Australian sugar industry

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Nutrient management in the Australian sugar industry shows symptoms of being both inefficient and unsustainable. Current fertiliser recommendations are generalised across regions and soils with some nutrients being commonly over-applied (N and P) whilst others are often under-applied (K and S). Tactical tools such as soil and leaf analysis are not widely used in the industry except for research purposes and growers have not generally adopted a scientific approach to nutrient management on-farm.

To achieve sustainability, which implies maintaining soil fertility, minimising off-site effects and ensuring profitable cane production, we have developed an integrated nutrient management program consisting of longer-term research strategies, greater adoption of tactical tools and an education and training program. The integrated approach consists of a number of different components: increasing farmer knowledge of sugarcane soils and their properties, understanding and managing nutrient processes, greater use of soil testing and leaf analysis, the development of innovative laboratory processes that better measure nutrient availability and loss processes, improved record keeping of on-farm nutrient use, the development of soil/site specific fertiliser recommendations, and the development of training courses and workshops for advisory staff and for cane growers.

This approach has been adopted in two contrasting sugar-producing regions (Herbert and Bundaberg) and we are now testing its applicability in two other regions. This program should deliver a system that provides cane growers with a logical basis for applying best practice nutrient management to different soils and regions within the Australian sugar industry and provides sufficient flexibility to accommodate both 'normal' and 'unfavourable' conditions, as related to both climatic events and sugar price. Currently, this integrated approach is being translated into an appropriate decision support package for use by both growers and by their advisers. It is envisaged that this package will have application not only to the different regions in the Australian sugar industry but also to other sugar-producing countries.

Keywords: Fertiliser recommendations, site-specific, sustainable production.

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Agrotechniques to enhance cane and sugar productivity under tropical conditions of India

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Six field experiments were conducted under tropical conditions of India on Vertisol soils during 1996-97 and 1997-98 to assess the effect of age at harvest, variety, and period of planting on cane and sugar yield. Average results of two seasons revealed that across periods of planting and varieties increasing the crop age at harvest from the 10th to the16th month increased cane and sugar yields by 27.8 and 4.68 t/ha, respectively. However, it was observed that at 14-month harvest date recoverable sugar levels were higher than at the 10-, 12- and 16-month harvest dates. Of the seven genotypes tested across periods of planting and ages at harvest,

CoC 92061, Co 86032, and CoC 671 produced the highest cane and recoverable sugar yields.

Based on these results it would appear that harvest schedules should be developed in which the varieties CoC 671, Co 85246, and CoC 92061 are harvested early (October to November). The harvest of these varieties would then be followed by the harvest of Co 86032 during the mid-harvest (December to March) crushing season to be followed by the harvest of CoC 671 and Co 85246 during the latter (fag) stages (April to May) of the crushing season. Irrespective of age at harvest and varieties, maximum cane yields were obtained when the crop was planted in January. However, planting in February produced the highest sugar yield (13.3 t/ha) primarily because the February planting date resulted in more days of favorable climatic conditions for the accumulation of sugar.

Keywords: Crop age at harvest, planting dates, variety, Vertisol.

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Evaluation of high density planting in Mauritius

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Nine trials were established between 1999 and 2000 to evaluate two techniques of planting cane at higher densities, namely dual rows and close rows. The most common cane row spacing used in Mauritius is 1.6 m whereas dual rows consist of pairs of cane rows 0.5 m apart with 1.8 m between their centres and close rows have three cane rows spaced at 0.5 m on a bed of 1.8 m width with 0.8 m between beds. Sub-plot and sub-sub-plot treatments consisted, respectively, of two N fertilizer rates (normal and + 25%) and either two sett densities (normal and a reduced amount) or two cane varieties. Increases in cane yield for plant cane and ratoon cane (first- or second-ratoon) varied across sites and were up 11% with dual rows and 41 % with close rows over the control with 1.6 m row spacing. The trials have also revealed that a reduced sett density may be used and there is no need to increase the N fertilizer rate with high density planting (HDP). Although yield increases to date with HDP have not been consistent, some producers are adopting the dual row concept as it does not incur extra costs and is advantageous in terms of weed control (canopy closing approximately four weeks earlier) and efficiency of their chopper-harvesters (pour rate).

Keywords: Cane yield, close rows, dual rows, row spacings, sugar cane.

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Effect of planting geometry and soil type on the yield potential of sugarcane

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Four field experiments were conducted to evaluate the influence of soil type and planting geometry on sugarcane growth and yield using the varieties CoC 671 (early maturing) and Co 86032 (mid-late). The first trial was conducted on a Vertisol (Mudhol series) using three planting geometries including paired rows (75 by 150 by 75 cm), wide rows (150 by 30 cm), and conventional planted rows (90 cm end to end). The paired row planting was superior to the other methods of planting in this experiment where yield attributes like girth, number of millable canes and plant height all contributed in producing the highest cane yield of 140 t/ha.

In the second trial also on a Vertisol, the conventional planting method was compared to a polybag-raised seedling method. In this experiment, the highest number of millable canes occurred in the conventional method of planting (79,000 canes/ha). However, the highest cane yields (93.4 t/ha) occurred with the polybag method of raising seedlings primarily because of a greater stalk size.

The third trial conducted on an Alfisol (Mudlagi series), evaluated different plant spacing regimes using tissue culture plantlets of Co 86032. Higher cane yields were obtained at the 90 by 60 cm spacing (148 t/ha) followed by the 120 by 60 cm spacing (145 t/ha). The increased yield in the tissue culture plantlets at the conventional spacing was due to a higher number of millable canes.

The fourth trial was again conducted on an Alfisol to compare the performances of CoC 671 and Co 86032 as influenced by planting geometry. Variety Co 86032 gave the highest cane yields (126 t/ha) under the wide (150 by 30 cm) row spacing, while CoC 671 produced the highest cane yield (135 t/ha) under the conventional (90 cm end to end) spacing.

It is concluded that profuse tillering varieties and tissue culture plantlets, especially those grown on a Vertisol, perform best at wide row spacings while low tillering varieties, especially those grown on an Alfisol perform best at narrow row spacings (90 by 30 cm).

Keywords: Alfisols, narrow row, tissue culture, Vertisols, wide rows.

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Harvesting more solar radiation for higher cane productivity

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Solar radiation is a major limiting factor to cane production in the high altitude areas of Mauritius and closer row spacing has been adopted as a solution compared to decreasing intra-row competition. The latter was assessed through increasing furrow width with varieties having differing canopy characteristics that are directly responsible for light conversion.

Field trials were conducted in 2000 and 2001, over two crop seasons for the first trial and in plant cane only for the second. In the first trial, the varieties M 3035/66, M 52/78 and R 579 were planted at a spacing of 1.3 and 1.6 m in furrows 15, 30 and 45 cm wide at the standard commercial planting density (28 000 setts/ha). A second trial included the varieties M 1400/86 and M 52/78 at the same furrow widths spaced 1.6 m at the commercial planting density and double this number.

In the first trial, cane yields were variable for both years with the best performance generally obtained with the widest furrow. The overall advantage amounted to 8.5 t/ha (7.4%) in plant cane and 8.0 t/ha (10.3%) in first ratoon. Considering the two-year mean results, the widest furrow under M 52/78 and R 579 gave 15 t/ha more cane than the narrowest furrow with a slight increase of 1.4 t/ha only in M 3035/66. Differences could not be clearly attributed to higher radiation interception.

In the second trial, increasing furrow width and planting density both led to higher cane yields. On average the widest furrow yielded 7.4 t/ha (14.8%) more than the narrowest, the higher planting density outyielded the commercial practice by 5.1 t/ha (9.8%), and the combination of widest furrow with higher planting density gave 13.5 t/ha (28.8%) more cane than the narrowest furrow at the low planting density. Increased cane yields resulted from higher tiller densities, which intercepted more solar radiation. Apart from improving productivity, decreasing intra-row competition can reduce costs of production through lower weed proliferation and ultimately herbicide usage.

Keywords: Competition, furrow width, light interception, planting density.

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Development of a controlled traffic, minimum till, legume based sugarcane cropping system

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Research conducted by the Sugar Yield Decline Joint Venture in Australia has shown that the long-term monoculture and the way in which it is practiced is having an important impact on the growth and yield of sugarcane. In particular the research has shown that breaking the monoculture with legume crops, reducing the amount of tillage, and avoiding trafficking crop rows with heavy machinery can each have positive effects on soil chemical, physical and biological properties and ultimately crop yield. The real challenge has been to combine controlled traffic, minimum tillage and legumes into a farming system that will provide improvements in productivity, profitability and sustainability. Recent initiatives in this area are proving successful and, although some problems remain to be overcome, we are confident that such a system will be adopted by the Australian sugar industry in the near future. In this paper we will discuss how the system has been developed and what effect its adoption is likely to have on the Australian sugar industry.

Keywords: Farming system, legumes, minimum tillage, soil health, sustainability.

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Sugar cane irrigation management under water scarcity

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Water is a scarce resource in the North and West of Mauritius from where some 30% of the total sugar production emanates. In other areas of the sugar industry with adequate water supply, production is sometimes limited due to water shortages during drought periods. Management of irrigation water is therefore of utmost importance and requires an innovative and sustainable approach. This paper elaborates the on-farm and commercial applications of deficit irrigation practices as a strategy to improve overall farm productivity. Management strategies to cope with water shortages, with particular emphasis on the use of alternative water resources such as sugar factory and municipal wastewaters, use of water retention chemicals and improvements in irrigation methods are also presented. Results of deficit irrigation trials have shown that it is possible to stretch the available water to an additional 11% of unirrigated area, thereby increasing overall cane productivity by 2.4% and water-use efficiency by 10%. Irrigation with factory wastewater produced similar cane yield increases as with 'normal' water, but its quality has to be closely monitored to avoid adverse effects on soil physical properties and the sprinkler systems. Furthermore, adoption of improved irrigation systems like the centre pivot has been shown to improve overall commercial yield by about 14%. The results emphasize the need to adopt emerging technologies for water management such as an integrated approach to irrigation management via the creation of an irrigation management information system to optimise cane productivity with available irrigation systems, labour and water resources.

Keywords: Deficit irrigation, irrigation management information system, wastewater, water savings, yield optimisation.

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The impact of fallowing and green manuring on sugarcane yields in Swaziland

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There are currently concerns within some sugar industries that long-term monoculture has led to soil degradation and consequent yield decline. Studies have previously been conducted in Swaziland to assess the effects of fallowing and green manuring on subsequent sugarcane yields. A comparison of commercial yield data initially indicated a response to fallowing of about 50% in the plant crop and 25% in the first and second ratoons, with no response thereafter. However this effect was shown, in part, to be due to seasonal variations in yield related to the time of harvest.

An investigation was conducted to assess the effects of fallowing and green manuring practices over a seven-month period on sugarcane yields and the physical properties of a poorly draining clay soil. There were yield increases of 10% and 8% in the subsequent plant and first ratoon crops after fallowing and green manuring, but there were no significant responses in the second ratoon crop. Topsoil air-filled porosity increased from 11% under continuous sugarcane to16-19% after fallowing, and steady state ponded infiltration rates were increased from 0.61 mm/hr to 1.34 mm/hr, but these improvements were no longer evident after a year back under sugarcane. Levels of soil organic matter were reduced in all cases, probably as a result of the tillage operations

involved. In the plant crop, root length was well correlated with air-filled porosity, indicating the importance of improving below-ground air supply for crop production on poorly draining soils.

The effects of a one-year fallow on sugarcane yields were studied on two contrasting soil types. In the subsequent plant crop, yields were improved by 16-29% after bare fallowing and 40-54% after green manuring, as compared to continuous sugarcane, with larger responses being obtained on the better soil type. However there were no significant responses in the ratoon crops.

The findings of these studies are consistent with those of other experiments conducted in southern Africa and Australia. Partly as a result of this work, fallowing and green manuring have now become standard practices at several sugar estates in Swaziland.

Keywords: Sugarcane, fallowing, green manuring.

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The effect of silicon on sugarcane yield

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Studies evaluating silicon applications to sugarcane have demonstrated beneficial effects on yield. Though not considered an essential element for plant growth, silicon is absorbed in large quantities and accumulates within the sugarcane plant. The accumulated silicon within the plant has been linked to: reduced pest attack and disease, reduced lodging, enhanced tolerance to frosts and water stress, and increased sugarcane photosynthetic capacity.

The use of cement as a source of silicon was shown to increase cane yields by 14 t/ha in the plant-cane crop. An experiment carried out at the Guaira Sugar Mill with the variety RB80-6043 showed that the application of calcium silicate (0 to 4 t/ha) increased silicon content in the tissue and resulted in an increase in cane and sugar yields. Field experiments conducted mainly on sandy soils, also demonstrated positive results for the use of silicon where yields increased from 11 to 16% in the plant-cane crop and from 11 to 20% in the ratoon crop.

Results suggest that silicon should be included in the fertilizer program as a "beneficial" element in order to maintain soil fertility, reduce environmental impact, and increase sugarcane sustainability.

Keywords: Calcium silicate, lodging, ratoon, slag, sustainability.

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Examination of the reduced growth phenomenon in sugarcane

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Biomass accumulation declines with age in many crops despite a seemingly adequate supply of the necessary inputs for plant growth. This paper will establish firstly the extent of the reduced growth phenomenon in sugarcane. Multivariate analysis will then be used to explore a range of physiological factors that may possibly be implicated in the reduced rate of sugarcane biomass accumulation over time (including loss of mature stalks, lodging, reduced rate of leaf appearance (phyllochron), reduced leaf area index and reduced leaf nitrogen levels). The importance of climate on biomass accumulation will also be explored by comparing cane crops grown under irrigation in hot dry climates, with those grown in cool and wet climates. A comparison will be made between crops that have grown normally (i.e. where yields match expected radiation use efficiency) with those that have failed to do so. Some possible reasons for the observed reduction in growth with ageing will be presented and a range of possible methods for reducing the impact will be discussed.

Keywords: biomass accumulation, intra-plant competition, radiation use efficiency.

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The effect of crop age, variety and time of harvest on sugarcane yields in Florida

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Sugarcane (interspecific hybrids of Saccharum spp.) is harvested over a 6-month (October - March) period in Florida, as well as over several ratoon crops. Growers must factor in crop age and varietal sucrose accumulation (maturation) characteristics when scheduling crop harvests. The objective of this experiment was to determine the effect of crop age and its interaction with variety and harvest date on sugarcane biomass yield and sucrose accumulation in Florida. Four data sets (termed "cases") were analyzed using repeated measures ANOVA.

Crop age, variety and time of sampling had highly significant effects ($P < 0.001$) on kilograms of sugar per ton (KST), tons of cane per hectare (TCH) and tons of sugar per hectare (TSH) in all 4 cases. Older ratoon crops had higher KST (1.4 to 10.6%), lower TCH (16 to 42%) and lower TSH (12 to 42%). KST was significantly lower in all cases from mid-October to mid-December relative to later harvest dates. TSH was significantly lower from mid-October to late November than later harvests. The reduction in TCH in older crops depended on the crop ages compared. All of the varieties tested had significantly lower TCH in second ratoon than plant cane, but only 14% had significantly lower TCH in third ratoon compared to first ratoon cane. Of the five varieties planted in all cases, CP80-1743, CP84-1198 and CP85-1382 appeared more stable in TSH across crop ages than CP88-1762 and CP89-2377. TCH was significantly lower in older crops in 33 of 38 sampling times in the experiment. TSH was significantly lower in older crops in

25 of 27 sampling times involving comparisons with plant cane, but only 4 of 11 times in the case comparing third and first ratoon. These results indicate that early-season harvest decisions have the most profound effect on sugarcane yield obtained, particularly when comparing plant and ratoon crop options.

Keywords: Saccharum, agronomy, ratoon, sucrose.

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Assessing the impact of salinity on yield and quality of sugarcane

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Sugarcane is regarded as having only moderate sensitivity to the impact of soil salinity on yield (Maas and Hoffman, 1977 - J. Amer. Soc. Civil Eng. Irrig. and Drainage Div. 103: 115-130). This standard largely was established from field experiments in the USA with NCo.293 and NCo.310 cultivars for plant cane only (Bernstein et al 1966 - Agron. J. 58: 489-493). Yield declined at 5.9% per dS/m increase in electrical conductivity of saturation extracts (ECe). These data were used in Australia for the past 33 years to interpret soil analysis and for provision of advice to canegrowers, even though the original publication reported that ratoon cane was at least twice as sensitive as was plant cane to soil salinity (Robinson and Worker, 1965- California Agr. 19(8): 2-3; Bernstein et al, 1966).

Re-assessment of the impact of salinity on sugarcane in fields in the southern region of Australia has confirmed relevance of Bernstein's standard for a plant crop of the less salt sensitive cultivar Q136, with a yield decline of 7.5% per dS/m ECe. However, yield of ratoon cane declined at 10.2, 11.8 and 16.9% per dS/m in ECe for the cultivars Q136, CP51-21 and CP44-101 respectively, as opposed to the existing standard of 5.9% per dS/m. An average loss of cane yield of 14% was reported for five cultivars in the Burdekin region of Australia, when results were interpreted against the average ECe for the 0-50 cm zone, rather than for a depth weighted average (Nelson and Ham, 2000 - Field Crops Research 66: 245-255). The higher ratio of ratoon to plant crops in commercial fields indicates the more sensitive standard for ratoon cane should be adopted for interpretation of salinity hazards in soil. These data also suggest sugarcane should be classified as sensitive to moderately sensitive to salinity damage, when our data are applied to classifications developed by Maas and Hoffman (1977). Commercial Cane Sugar (CCS) also declines with increasing soil salinity, at rates between 0.27 and 0.92 CCS units per dS/m ECe. Electrical conductivity of juice increases with increasing salinity as a reflection of increasing ash levels in juice. Salinity therefore has an important and negative effect on the yield of sugarcane and quality of the extracted juice.

Keywords: Cultivars, salinity, salinity hazard, salinity thresholds, sugarcane.

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Rainfall pattern and soil moisture effects on erosion and phosphorus transfer from sugar cane fields to surface waters in Mauritius

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Eutrophication is a major problem in many inland surface waters with phosphorus (P) being the main causative nutrient. Phosphorus transfer to surface water in Mauritius is intimately linked to sediment transport occurring during rainstorm events. Rainfall pattern and soil moisture conditions influencing sediment and P transport were examined in a 54-ha watershed receiving 3000 mm rain annually and where sugar cane is cultivated on a silty clay loam having a 5 to 12% slope. The watershed was instrumented along its natural drainage line with a San Dimas-like flume fitted with a pressure transducer, datalogger, and an automatic ISCO water sampler.

Most of the sediment and phosphorus were moved early during a runoff event. The erosive power of the rainfall event was primarily influenced by rainfall intensity, total rainfall being of secondary importance. A 130 mm rain - in a 3-hr period with a 5-min peak intensity of 128 mm/hr - moved 0.11 t sediment/ha and 0.4 t P/ha. On the other hand, the sediment movement was reduced six-fold when the rainfall intensity was 71 mm/hr in an event delivering 290 mm of rain. The severity of rainfall intensity could be enhanced by increasing soil wetness. A 2-hr rainfall with 68 mm rain at a low intensity of 68 mm/hr moved 0.1 t sediment/ha and transferred 0.02 kg P/ha under high soil moisture. The present study showed that factors influencing sediment and P transport from soils under sugar cane are not different from those in temperate region soils. Innovative and practical measures that control sediment and nutrient losses in temperate environments should therefore be equally effective in sugar cane soils of the tropics.

Keywords: Eutrophication, rainfall intensity, tropics.

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How much down the ditch? Perception and realities

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Sugar cane fields comprise about 45% of the total land area of Mauritius. This has caused a strong perception during the past decades that the sugar industry is a major polluting agent in Mauritius, especially after heavy rains. Preliminary results obtained from lumped catchment hydrology modeling of agrochemical movement in tropical sugar production have shown that the N pollution of streams is agronomically not important, but may be environmentally significant.

However, a closer look at the catchment revealed the incidence of point source pollution inputs from other inland and in-stream

activities, apart from sugarcane cultivation. Their contribution to the detected N loads was ignored in the original catchment N model. In addition, the fact that the catchments in Mauritius are found mostly on a multilayered aquifer zone with faults, the subbasin definition, stream nodes and soil parameters need to be refined with soil pit data, borehole data, and geology information.

A methodology adapted for the Non-Point Source (NPS) pollution evaluation in a catchment is presented to improve the flow calibration of the geologically complex catchments of Mauritius. A framework for various sources' data compilation and preprocessing is proposed to generate the necessary parameters as inputs into a simplified integrated surface and subsurface model, based on topography, geology, and land use. Two models using Geographic Information System tools were selected for the study: Soil and Water Assessment Tool (SWAT), a physically-based distributed surface water hydrology model, and Hydrogeomorphic Analysis of Regional Spatial Data (HARSD), a groundwater modeling software which classifies landscape into hydrogeomorphic units for subsequent inference of hydraulic head surface. The latter is used as input into a groundwater flow model for flux calculations. In addition, a submodel is derived from the balance sheet for N sources and sinks in the catchment. The thematic layer derived for N contribution by sugarcane to catchment would be used to crosscheck the measured values, after elimination of point sources pollution detected along the stream. Using these models, a better picture of sugarcane's contribution to NPS pollution in the catchment has emerged.

Keywords: Geographic information system, surface and subsurface hydrology modeling, non-point source pollution, sugarcane.

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Sugar cane fields: a disposal route for organic wastes?

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More stringent regulations will emerge to protect the environment from the increasing organic wastes being generated. Of all the disposal options available, only agricultural re-use of these organic wastes produces economic benefits as the wastes contain plant nutrients and act as a soil conditioner. However, agricultural re-use warrants careful considerations because the wastes contain heavy metals and other unwanted constituents and high application rates may result in excessive nitrogen (N) mineralization and increases in NO3 levels in water which can be hazardous to man and animals. Agricultural re-use of organic wastes in sugar cane fields was studied in lysimeters and field trials using sewage sludge as the source of organic waste. Rates of sewage sludge from 0 to 60 t/ha were compared against the standard practice of applying mineral N fertilizer at 140 kg/ha to sugar cane.

Determination of Cd, Cr, Cu, Hg, Ni, Pb and Zn in leachates showed concentrations below detection limits even when sewage sludge was applied at 60 t/ha. Thus, sewage sludge disposal on sugar cane soils in Mauritius presents little risk of groundwater contamination by heavy metals. Furthermore, concentrations of heavy metals in sugar cane treated with sludge at 60 t/ha were not significantly higher than in the control plot. Repeated yearly applications of sewage sludge would, in the long term, not cause any appreciable rise in the concentrations of heavy metals in sugar cane. Additionally, sewage sludge at the higher rate of 60 t/ha produced lower nitrate concentrations in the root zone relative to the standard 140 kg/ha application of mineral N fertilizer. The results of this study suggest that sugar cane fields can provide a safe outlet and a sustainable option for the disposal of organic wastes.

Keywords: Heavy metal, nitrate, pollution, sewage sludge.

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Cool burning reduces particulate matter emission in Mauritius

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Cane burning prior to harvest is a common practice in the humid and subhumid zones of Mauritius; approximately 25% of the total area under cane was burnt in 2001. Cane burning has been traditionally carried out in the late afternoon, resulting in emission and deposition of large amounts of particulate matter or ash in the neighbouring residential areas including swimming pools of hotels located in the vicinity. A survey carried out in 2000/2001 has revealed that cane burning was perceived as a serious nuisance by 78% of the inhabitants and 86% of hotel managers. Increasing pressure and complaints from the public have forced the authorities to contend this agronomically very cost-effective practice. Field trials were conducted to compare burning fields early in the morning when the wind is low and the dew is usually present on green leaves (cool burning) to the traditional practice of late afternoon burning. Medium to coarse particulate matter emitted above the cane canopy was collected and measured to compare the effectiveness of the various types of burns. Cool burning reduced particulate matter emissions by more than 60%. A code of burning practice based on adoption of cool burning and including a communication campaign was proposed for the 2002 crop and was adhered to by most of the large producers. It seems that the changes brought forward have been appreciated by both the authorities and the public, and will help in preserving the practice of cane burning.

Keywords: Cane burning, code of practice, sugar cane, time of burning.

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Environmental pressures, challenges and strategy for the sugar grower in South Africa

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Certain sugar cane farming practices are seen as having a negative impact on the environment. The South African sugar cane grower is increasingly coming under pressure due to these negative environmental issues, especially where cane fields border

housing developments and prime tourist destinations. The global perceptions regarding the negative impacts on the environment associated with sugarcane production are very similar around the world. The common negative impacts such as water availability, water contamination, cane burning, reduced soil quality, use of agro-chemicals and lack of bio-diversity are discussed. The environmental pressures recognized as being of greatest concern in South Africa are discussed. They include the common global impacts as well as localized issues concerning land use planning, wetlands and watercourses. International environmental issues affecting the worldwide sugar industry encompass the following: air pollution, genetically modified organisms, labour issues, fresh water use and soil degradation. The major challenges facing the South African sugar cane grower have been identified as: grower-miller partnerships, development and implementation of sound best management practices, upliftment of the small tribal grower and to be world leaders in environmental management. A possible environmental strategy for the South African sugar cane grower includes: implementation of an environmental management system, development of environmental publications, promoting positive environmental impacts, promoting environmental awareness in schools, development of environmental education programmes, and sponsoring of education grants in the environmental field.

Keywords: Bio-diversity, burning, cane spillage, degradation, impacts, natural resources, sustainable.

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Progress of precision agriculture in sugar cane in Mauritius

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With a view to investigating its potential in the identification of spatial yield and soil variabilities under Mauritian conditions, a project on precision agriculture in sugar cane was initiated two years ago. A yield monitor system, including GPS, has been mounted in a cane harvester to conduct in-field spatial yield variability mapping, whereas soil conductivity surveys have been manually carried out with the EM38 soil electromagnetic conductivity meter. Visual interpretation of aerial photographs and satellite images has also been applied to detect spatial variability within the field. The site of investigation is a sub-humid coastal area in western Mauritius dominated by two soil groups and irrigated agriculture. Within field yield variability was significant and tended to occur as banded and non-banded patterns in irrigated as well as non-irrigated fields. Yield mapping of one field (field 6201) in 2001 and 2002, indicated that yield variability was present in nearly the same range and geographical locations in spite of differences in average yield obtained in 2001 (62.8 t/ha) and 2002 (56.8 t/ha). Yield variability in that field was not related to variability in topography or soil electromagnetic conductivity. In other fields, a relationship between yield variability and soil conductivity was found to exist in certain areas only. Zones of cane canopy density, as visually interpreted from aerial photographs and satellite imagery for field 6201, were found to relate to zones of variable yield. Soil sampling is being carried out for analyses to correlate soil properties to yield variability and soil conductivity in specific areas. The two-year yield monitoring of field 6201 indicates that there is opportunity for in-field yield variability management on an annual basis, for example, by making adjustments in the applications of fertilizers and irrigation.

Keywords: Soil conductivity, spatial variability, variability management, yield monitoring.

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Use of a Geographic Information System to report low temperatures following freeze events in the sub-tropical agricultural production region in South Florida, USA

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The Florida sugar industry is faced with evaluating damage of sugarcane fields for harvest following freeze events in roughly one in five years. Acquiring imagery data can be expensive and more importantly cannot often be obtained in a timely manner following freeze events. Given these constraints, the sugarcane industry in Florida developed a ground-based network of electronic recording thermometers to generate a GIS database to report the regionally distribution and duration of low temperatures following freeze events in the sugarcane production area of south Florida. The authors met with local managers to propose a set of standards that defined the regional distribution of recording thermometers, standardized the installation height and location of thermometers within cane fields, and identified the programming protocols for each recording thermometer. A database program was written in Microsoft Accessâ software to summarize the data to report minimum temperature and duration at several below-freezing threshold temperatures. This system was used in the 2002/2003-harvest season during the freeze events that occurred on January 19, 2003 and January 24, 2003. Sensor temperature data were downloaded the morning of the freeze event. The raw data were posted on a File Transfer Protocol (FTP) site accessible to the three milling companies. Each company processed the data and generated contour maps using ESRI ArcMap 8.2â software utilizing the ESRI Spatial Analyst Extensionâ. These maps allowed management to rapidly target locations that most likely required immediate determinations of the extent of freeze damage. The maps and data reports were also made available to growers through a secure website. These maps allowed field personnel to target areas potentially damaged the most, thereby making field evaluations more efficient and allowing timely management decisions regarding the harvest.

Keywords: Databases, mapping, sugarcane (Saccharum spp.).

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Decision support for optimal variety selection on a farm scale for South African sugarcane growers

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In 1990, a decision support program (DSP) known as VTYECON was developed by Inman-Bamber at the South African Sugar Association Experiment Station (SASEX) to calculate and optimise the net economic value of varieties under specific agroclimatic and economic conditions. The adoption of the DSP was slow due to insufficient support in the way of user-friendliness and manuals.

Subsequently more emphasis is now placed on technology transfer and improving some of the limitations identified in the previous system. The Internet has been considered as a strategic facility for information dissemination. It also centralises processing, therefore enabling the SASEX variety agronomist to update and add variety information readily.

Some of the more exciting features of the new DSP will be discussed in this paper. One of these features is that cane yield is determined for each variety using a range of factors, such as thermal time, rainfall, soil properties, water stress, and pest and disease susceptibility. Another is that the new DSP calculates sucrose, fibre and non-sucrose for different varieties, which vary depending on rainfall, evaporation and temperature conditions under which the variety is grown and the age at harvest.

The new DSP is user-friendly. Users will download an Excel spreadsheet from the Internet into which growers can enter their agro-economic, climate and topographical farm information. This information is then submitted to a web site where a centralised Oracle based system estimates the annual profit per hectare per variety under the given set of conditions. The system then selects the most profitable varieties including a planting and harvesting schedule under the given agro-economic conditions. Growers are required to enter their risk profile. This ensures that a single variety or harvesting cycle will not be recommended for a whole farm situation thereby avoiding a disease or pest epidemic. After submitting these details to the web page the DSP then generates a final report giving a recommendation on the best variety strategy for the growers particular set of conditions. This information can then be saved or printed.

Keywords: Agroclimate, economic value, Internet, SASEX.

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Agronomic decision support on the Internet

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Sugarcane yield and quality are determined by the response of the plant to soil and atmospheric conditions. The manager could manipulate this interaction, but must base his actions on relevant and timely information about crop status and growing conditions. This paper describes a Web-based system to support strategic and tactical decisions regarding sugarcane agronomy.

The system consists of a crop model linked to real time weather data from 17 automatic weather stations situated in the South Africa sugar industry. The user specifies the water holding capacity of the soil, crop cycle dates and the irrigation scenario. The crop water status, canopy cover and yield of past and current crops are calculated. Information is summarized and presented in data tables and graphs. Daily climate, crop and soil information could be downloaded for further analysis.

Actual examples of using the system to support sugarcane agronomy are discussed. These include (1) yield benchmarking to identify nutritional, weed or stalk population problems, (2) assessing the suitability of rainfed crops for chemical ripening, (3) assisting with yield forecasting, and (4) assisting with understanding peculiar crop responses to the environment. Potential applications such as irrigation planning are also demonstrated.

Keywords: Cane yield, crop model, weather data.

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The development of a chemical fertilizer recommendation system for sugarcane production in Thailand

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Chemical fertilizer accounts for a substantial part of the sugarcane production costs in Thailand. Most cane growers in Thailand lack basic knowledge regarding the use of fertilizers. Misapplication of fertilizer increases production costs, decreases fertilizer efficiency, and causes environmental damage. A computer programme, CaneFert 1.0, is being developed to accurately determine recommendations for the application of N, P, and K based on the properties of the various soil series used for sugarcane production throughout Thailand. The project includes: sugarcane soil identification using soil series maps, field surveys to confirm the identification, determination of nutrient requirements, cane simulation using CANEGRO 3.5 to determine the effect of water and nitrogen, economic analyses of chemical fertilizer recommendations and validation trials to confirm the recommendations generated by CaneFert 1.0. The resulting software allows users to locate the site of their farm by pointing an arrow on a map displayed on the computer screen. The farm's location, soil series, soil chemical properties, N-P-K requirements, and the amount and method of chemical fertilizer application are also generated. It is anticipated that sugar mills, sugarcane grower associations, government agencies, agronomists, and extension workers will use this software.

Keywords: Fertilizer recommendation, simulation model, soil analysis.

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The use of a yield simulation model to improve harvest planning and yield estimates on large commercial irrigated estates

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Large commercial sugarcane estates (>7000 ha, >100 fields) face complex harvest planning decisions on issues such as season

start and duration, field harvest sequence and dates, cutting front allocations, etc. A sugarcane yield estimate is central to these decisions. Typically yield estimates are based on historic performance, do not account for current growing conditions, and largely ignore changes in harvest age. A simple potential yield model was developed based on the CANEGRO crop model and incorporated into the harvest planning module in CanePro, a commercially available sugarcane agricultural information system. Given season start and duration, an anticipated estate delivery schedule (tons/day) and harvest sequence, and meteorological data, the harvest planner was able to estimate harvest dates, age and cane yield using the potential yield model. Cane yield was estimated from an analysis of historical field performance, expressed as the ratio of actual yield to the climate potential in that season (performance ratio), and the forecast yield for the coming season. As additional meteorological data became available, the harvest plan was recalculated, capturing the effect of recent growing conditions in the estimate. In Swaziland, prior to the start of the 2000/2001 season, this model was used successfully to plan and estimate yields to a greater accuracy (< 1% variance) than estate generated estimates (as much as 13% variance). During the season as actual yields replaced estimates the model was used to further fine tune the harvest programme and assess the effect on the standing crop. This approach has the potential to optimize both agricultural (harvest age, yield etc) and milling performance (season start and duration) through a better understanding of the driving mechanisms at work in this complex system.

Keywords: CANEGRO, CanePro, computer simulation.

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Enhancing the performance of Canegro-DSSAT V3.5 model through the use of real time dewpoint temperature and windrun

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Crop modeling, a discipline that is being increasingly accepted as a cost-effective support to conventional agricultural research, requires reliable weather data for precise evapotranspiration estimates within simulation exercises. The DSSAT V3.5 simulation platform allows the computation of evapotranspiration by different means, namely, the Richie Modification of the Priestley-Taylor method that requires daily minimum and maximum temperatures, rainfall and solar radiation and the Penman-Monteith option, a more accurate method that requires in addition windrun and dewpoint temperature. Since dewpoint temperature is not measured, a program was developed in FORTRAN for its calculation from recorded wet-bulb and dry-bulb temperatures using the Clasius-Claperon method combined with the psychrometer equation.

Simulations were run with the validated Canegro model to assess the importance of weather parameters on the evapotranspiration estimates by the two above methods and to evaluate their impacts on cane yield of variety R 570 grown from 1991 to 1998 under water regimes ranging from rainfed to full water requirements at Tamarin. The regression of simulated on observed dry cane yield range of 3 t/ha to 55 t/ha, showed that the best simulations were obtained when the dewpoint temperature and windrun data were specified and the Penman-Monteith evapotranspiration method was adopted. When windrun and dewpoint data were not used, the Richie Modification of the Priestley-Taylor option resulted in an underestimation of 10. 9 t/ha of dry cane while the Penman-Monteith option resulted in an underestimation of 5.9 t/ha. The importance of using real time dewpoint temperature and windrun in modeling studies and the evapotranspiration estimate to be adopted are demonstrated.

Keywords: Evapotranspiration, modeling, sugarcane.

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A proposal for the establishment of a multi-national consortium to develop and maintain the DSSAT Canegro sugarcane model

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The Canegro sugarcane model simulates the daily energy, water and biomass balances of a sugarcane crop using atmospheric, soil, cultivar, and management inputs. South Africa and Swaziland maintain, improve and apply independent versions of the model. An older version of the Canegro model is distributed as part of the decision support system for agrotechnology transfer (DSSAT version 3.5) to registered users worldwide. The purpose of the DSSAT multi-crop modeling system is to act as a framework to promote scientific co-operation and to globalize the application of crop models.

The Canegro model has been used successfully to support agronomy research, forecast cane yield and support agronomic management of sugarcane production. The model has been calibrated and tested against observations in South Africa, Swaziland, Mauritius, Australia and Thailand with varying degrees of success. Although significant modeling advances have been made recently, these have not been incorporated within the DSSAT shell and are not available to DSSAT users. Although model source code is freely available, programming and modeling expertise are required to refine models for local conditions and to incorporate improvements into the DSSAT shell. Furthermore the DSSAT system is currently being redesigned to enable easy interchange between modules and to standardize on common, soil and atmospheric modules. The Canegro model needs major revision to make it compatible with this new system. This revision should also address the need for model documentation and a crop management module capable of simulating long-term sugarcane rotations.

It is proposed that a consortium of potential DSSAT Canegro users be established to address these issues. The aim would be to ensure the continued maintenance and inclusion of sugarcane modeling advances into the DSSAT system. It is envisaged that consortium members contribute financially and in kind towards approved projects. The main cost would be salaries for consultants or postgraduate students. Benefits would include (1) access to advances in our understanding of the crops' response to the environment and management, and (2) a more robust model tested under a wider range of growing conditions and genotypes.

The paper will present examples of the successful application of Canegro. Recent advances and the main limitations of the model will be discussed. Problems with the DSSAT v3.5 will also be highlighted. Different options will be discussed for the establishment and role of a DSSAT Canegro consortium to address these challenges.

Keywords: Canegro, DSSAT, maintenance, research, management