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Theme "Integrated agronomic practices to improve/sustain cane productivity"

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SESSION 1

ABSTRACT 1

International applications of electromagnetic induction measurements for understanding the impact of soil properties on cane growth

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KEYWORDS: Electromagnetic Induction, EM38, Earth Conductivity, Salinity, Soil Variability

Electromagnetic induction instruments provide rapid and non-destructive measures of bulk electrical conductivity of earth. Values depend largely on electrolyte levels, clay content and to a lesser extent moisture. An EM38 instrument was used in Australia, Pakistan and South Florida to support applications outlined in this paper.

The EM38 was used in Australia and Pakistan to delineate severity of soil salinity impacts on sugar cane. There was a significant ($p<0.05$) correlation between EM38 readings and electrical conductivity of the saturation extract (ECe) with r2 values ranging 0.70-0.91, while r2 for the regression of EM readings on relative cane yield ranged 0.74-0.82. Comparison of readings for vertical (EMV) and horizontal (EMH) dipole modes indicate the general shape of the salinity profile and prospects for root zone leaching.

Histosol (muck) soils in Everglades Agricultural Area (EAA) South Florida formed over a relatively non-conductive bed of coralline limestone. There was a significant correlation ($p<0.05$) between EMV and soil depth ($r2=0.82$) across 13 sites in the EAA, where soil depth was less than 100 cm. We found relationships for soils containing a significant amount of peat were different to those containing muck only. R2 for multiple regression of EMV on depth and dummy soil variables was 0.89. Shallower soils generally contain less peat than deeper soils, so implications for correct classification of soil is much less significant when there is only about 40 cm of soil. There was a low ($r2=0.52$), but significant, negative correlation between soil depth and pH, suggesting potential for using EM data to control variable rates of sulphur application to manage pH on the shallower soils.

Sandy soils to the east of the EAA are renowned for variability in physical and chemical properties. We found that EM values across 120 ha were highly correlated (r2=0.85-0.97) with average clay content or electrical conductivity of 0-50, 0-75 and 0-100 cm profile depths - salinity was not an issue. EM readings were not correlated with chemical fertility parameters of the 0-25 cm zone, due to contemporary management. Maps of soil variability can be prepared from EM data and these would define sandier areas more prone to drought stress and needing more attention in terms of split applications of nitrogen, provided areas are large enough to form management units.

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ABSTRACT 2

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

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Keywords: Farming System, Legumes, Tillage, Profitability, Sustainability.

This paper reports on progress in the development of a new sugar cane cropping system in Australia. It is an update of a report presented to the last ISSCT Agronomy Workshop held in 2003 in Mauritius when the concept of a more profitable, sustainable and environmentally responsible sugar cane cropping system based on the three basic principles of minimum/zero tillage, controlled traffic and legume break crops was introduced. Since the last workshop much of the research and development work in this area has focussed on large scale, grower-oriented experiments aimed at practical solutions that aid in the commercial implementation of the system. The presentation concentrates on the recent results from that research and the progress with adoption of the system. It is argued that although the new system may not be providing major yield increases in the short-term it certainly results in substantial cost savings and improvements in timeliness of operations and so it is more profitable. Further there are indications that long-term yield improvements will be recorded through better maintenance of organic matter resulting in improvement in soil health.

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Increased cane yield and economic return by dual-row planting in cane grower fields

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Keywords: Double-row, Single-row, Millable Stalk, Stalk Length, Juice Quality

Field trials with dual-row planting system were conducted at four locations in sugar cane farms belonging to different cane growers. Most trials were under rainfed conditions in Khon Kaen and Chaiyaphum districts. Two planting methods (110-50 cm double row and 100 cm single row) were evaluated using two varieties (K84-200, poor tillering and K 88-92, good tillering). The experimental design was a randomized complete block with four replications.

Plant cane dual-row planting increased cane yield by 30 and 32 tonnes ha-1 with K84-200 and K88-92, respectively, compared with single row planting. In ratoon, cane yield increased by 15 and 26 tonnes ha-1 with K84-200 and K88-92, respectively. The increase in cane yield was found to be significantly correlated with the number of millable stalks, stalk length, and stalk weight. However, cane juice quality was not affected by the different planting methods. Economic analysis showed that an increased profit of US$ 177 and US$ 356 ha-1 can be achieved in plant and ratoon cane, respectively, from dual-row planting of K88-92. With K84-200, growers obtained an increased profit from dual row planting of US$ 130 and US$ 181 ha-1 in plant and ratoon crop, respectively.

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ABSTRACT 23

Sugar cane response to chip bud method of planting

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KeyWords: Seedling, Transplanting, Tillers, Juice Quality, Cane Yield

sugar cane being a vegetatively propagated crop, 10 to 12% of total cane production is used annually as seed material for the ensuing crop. The cost of seed material itself accounts for 16 to 18% of total production cost. Even though such a huge quantity of seed material is planted, the productivity of the cane primarily depends on the final stalk population and individual cane weight at harvest. An alternative to reduce seed cost is to plant only the cortical portion or bud of the cane stalk and process the remaining portion of stalk. Field experiments, conducted on different chip bud planting methods, revealed that planting seedlings grown on raised bed or polybags for 40 days at 80 x 25 cm spacing could enhance productivity. These seedlings produced 63 % more early tillers, well-developed stalks with high juice content, and cane yield of 108 tonnes ha-1 compared to 55 tonnes ha-1 with direct planting of chip buds. The seedling method was comparable with the conventional system of planting two-bud setts. Moreover, the seedling method enhanced cane quality with increases in juice extraction and commercial cane sugar of 8% and 0.9%, respectively, compared to the conventional system. Early synchronous tiller production, higher conversion of tillers into cane population, and

uniform final stalk population resulted in higher juice quality. This method of planting also resulted in a higher benefit to cost ratio by saving 90% of seed cane.

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ABSTRACT 4

Use of trinexapac-ethyl to improve seed quality in mechanically planted sugar cane in Florida

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The ability to achieve a consistent quality stand of sugar cane following mechanical planting is a key factor in the long-term sustainability of the Florida sugar cane industry. The short length of seed pieces used for mechanical planting and the physical damage sustained from chopper harvesters results in greater susceptibility to stalk rot compared to hand planted seed cane on Histosol, soils where prophylactic fungicides appear ineffective. Consequently, higher seeding rates are required for mechanical planting to achieve an adequate shoot population. A trial was conducted in 2005 to evaluate the efficacy of trinexapac-ethyl (a chemical that inhibits production of gibberellic acid) for shortening internode length in sugar cane. Based on preliminary research, commercial fields of CP 84-1198, CP 78-1628, CP 80-1743, CP 89-2143, CP 88-1762, and CL 77-797 were treated with a split application of trinexapac-ethyl at 183 g ai/ha + 148 g ai/ha in late spring. In fall 2005, sub samples of treated and non-treated seed cane were randomly collected from each site and internode length and diameter were recorded. In November, mechanically harvested seed pieces of each cultivar were planted in a randomized split plot trial to evaluate the effect of treatment with trinexapac-ethyl on shoot population. Treatment resulted in shorter average internode length in CP 89-2143, CP 88-1762, and CP 78-1628. Results on internode diameter will also be presented. Compared to the untreated control, CL 77-797, CP 89-2143, and CP 80-1743 treated with trinexapac-ethyl had higher shoot populations 40 days after planting. Early results indicate that for some cultivars use of trinexapac-ethyl to shorten internode lengths may result in higher shoot populations for mechanically planted sugar cane.

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SESSION 2

ABSTRACT 14

The effect of trash on the growth of sugar cane in high altitude areas

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Keywords: Trash Blanket, Yield, Soil Temperature, Soil Water Content, Cane Growth

In South Africa, research on the effect of trashing (residue left behind after green cane harvesting) on cane growth and yields has been restricted to the low lying coastal areas despite the fact that a significant proportion of the sugar industry is in the Midlands region, at altitudes above 500 m and experiencing occasional frosts during the winter months. Recent concerns about the level of burning in the South African sugar industry have urged us to also investigate the effect of trashing on cane growth and yields in high altitude areas. Two trials were established: (1) at Fairview on a clayey Oxisol (55% clay, 3.8% organic matter, ratooned in July in a 24-month cycle and (2) at West Cliff on a sandy soil (15% clay, 0.4% organic matter), ratooned in July in a 24-month cycle. Over the past five years, no significant effect on yield due to trashing was recorded at either site. Trashing greatly reduced stalk population initially, but had no effect on final stalk population, stalk length or cumulative light interception. Hourly temperature measurements at the Fairview site showed that under incomplete canopy the upper 5 cm soil layer was on average 8.0 oC warmer (cumulative per hour from 6:00 to 18:00) under the trash blanket in winter (June to August) compared to the bare surface of the burnt treatment. In summer (December to February) the upper 5 cm layer was on average 7.1 oC cooler under the trash blanket. No change in soil water content was observed for rainfall events of less than 10 mm under the trash blanket. Further investigation will address the risk of below 0 oC temperature occurrences just above the soil or trash surface.

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ABSTRACT 36

Post-Harvest management of sugar cane residues in the temperate climate of Louisiana

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Keywords: Green Cane Harvest, Residue Management, sugar cane Ratoon, Allelopathy

Retention of post-harvest residue can decrease cane yield by 4.5-13.5 tha-1 in the temperate climate of Louisiana. A series of experiments was conducted to determine the physiological causes for this loss and to develop management practices to mitigate the

effects of residue retention. Chemical extractions revealed the presence of benzoic acid in the residue, which reduced cane germination by 50%, compared to the control (water only), through potentially allelopathic reactions. Residue retention was also shown to decrease leaf area. Regression analysis showed that for every 1 tha-1 of residue, sugar yields were decreased by 0.13 tha-1. Management research demonstrated that sugar and cane yield reductions were greater on third (12 and 10%) compared to second (4 and 1%) and first (3 and 2%) ratoons. In prior research, residue retention lowered cane yield, resulting in lower sugar yields. This study showed that both a decrease in cane yield and sucrose concentration caused lower sugar yields. Irrespective of ratoon age, mechanical removal of residues to the wheel furrow proved similar to burning, and both removal methods increased cane yields over the control (no removal). Incorporation of residue once placed in the wheel furrow did not increase yield, but may aid in decomposition. Data indicated that, across ratoons, residue should be removed when the crop becomes dormant (usually in January in Louisiana). If removal is delayed until the crop is actively growing (usually in March in Louisiana), mechanical removal is the only option because burning will result in an additional 11% reduction in sugar yield when compared to full retention. To conclude, sugar cane post-harvest residue has multiple detrimental physiological effects on sugar cane. Moreover, stubble age, soil type, method and timing of removal should all be taken into account when making residue management decisions with priority paid to the older ratoons.

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ABSTRACT 6

Fertilizer nitrogen as a factor to prevent sugar cane yield decline in organic soil

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Keywords: C/N Ratio, Fallow Planting, Roots, Successive Planting, Yield Decline, Sucrose

Sugar cane is usually replanted every three years on organic soils in Florida due to yield decline. Literature has reported yield decline may result from a depletion of available soil nutrients. We hypothesized that successive planting increases soil C/N ratio which allows soil microbes to immobilize inorganic nitrogen (N) to create N deficiency. A field experiment was conducted over the plant and first ratoon crops of sugar cane on an organic soil to determine if fertilizer N reduces yield decline in sugar cane. Treatments were:

- two fields (a field previously planted to rice henceforth called fallow and a field previously planted to sugar cane henceforth called successive) and,
- four fertilizer N treatments (ranging from 56 to 224 kg N ha-1) plus a 0 N control.

Fertilizer N did not prevent yield decline in fallow or successive fields. Fresh cane yields declined by 6 and 10% in fallow and successive fields, respectively. However, sucrose yield was only reduced in the successive field (7%). The decline was not due to reduced stalk populations as stalk population increased from plant to first ratoon cane. Reduced cane yields resulted from decreased stalk weight over time. Root mass, length, and surface area densities near the plant were also reduced in both fields after the last harvest, indicating potential disease. But visual observations of roots did not indicate the presence of disease. Soil insects were not at threshold levels to cause yield reductions. Soil C/N ratios were not affected by N fertilization, but were increased over the two year period from 14 to 16 and 15 to 17 in the fallow and successive fields, respectively. Our data suggest that sugar cane yield decline on organic soils may be related to pathogenic or autotoxic factors rather than N deficiency due to immobilization.

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ABSTRACT 30

Increasing ratooning ability of sugar cane in Northeast Thailand through genetic and cultural improvement approaches

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Keywords: Long-term Breeding Program, Drip Irrigation, Filter Cake, Green Manure

Approximately 40% of the total sugar cane production in Thailand are obtained in the Northeast, but the productivity there is low due to a number of contributing factors. Soils, in general, are sandy in texture, low in fertility, and low in water holding capacity. Although the amount of rainfall in this area seems adequate for sugar cane growth, its distribution is erratic. The low-input cultural system which prevails in the Northeast combined with the above adverse factors, result in poor crop yields and ratooning ability. Despite the development of irrigation systems, some of which have yet to become fully operational, the majority of the growing area is rain-fed.

The 24 multi-location trials in this area with 12 elite sugar cane varieties revealed that cane yield decreased from 60 t ha-1 in plant cane to 38 t ha-1 in ratoon cane, while sugar yield decreased from 8.18 t ha-1 in plant cane to 5.41 t ha-1 in ratoon cane. To increase ratooning ability, Khon Kaen University initiated a long term breeding program in 1995. A total of 325 sugar cane lines of diverse origins were collected and screened for ratooning ability. Fourteen lines were selected and used as parental lines. At least three promising lines were selected from segregating populations and are being evaluated in standard field trials during crop years 2004-2007.

The other approach to sustain sugar cane yield is cultural practice improvement which included soil improvement through green-manure crop rotation (pigeon pea and sunhemp) and soil amendment with filter cake from sugar mills. These approaches commonly practiced in the Northeast help to increase organic matter and water holding capacity. Drip irrigation is now the most efficient method

to sustain sugar cane yield and increase ratooning ability. Low-cost drip irrigation systems have been developed by many companies, and this technology is now widespread among sugar cane growers in the Northeast. It increases cane yield and ratooning ability, which reduces production cost and increases the competitiveness of Thai sugar industry.

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ABSTRACT 7

The adverse effects of poor soil health can be masked in high input sugar cane production systems - but at what long-term cost?

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Keywords: Farming System, Water, Nitrogen, Monoculture, Yield Decline

When the sugar cane monoculture is broken or long-term sugar cane land is fumigated prior to re-planting, crop establishment is enhanced. In many situations this improved crop establishment is instrumental in ultimately producing higher cane and sugar yields. However, recent studies in rotation experiments in the Burdekin delta have shown that, with high inputs of water and nitrogen fertilizer, tillering is enhanced to the extent that poor establishment of primary shoots is compensated for by the production of more higher order tillers, resulting in the ultimate yield differences between breaks/fumigation and plough-out/re-plant being reduced. This effect led to a general conclusion that there was no yield decline (poor soil health) in the Burdekin delta. Clearly, research by the Sugar Yield Decline Joint Venture (SYDJV) has shown that soil health is as much an issue in the Burdekin as anywhere else. The response to high inputs has several important implications. Certainly, high inputs provide a means by which poor crop establishment associated with poor soil health can be compensated for and yields maintained. However, the long-term consequences of ignoring soil health need to be considered. Further, the excessive use of resources, such as nitrogen fertilizer and irrigation water, has both economic and environmental consequences. In this paper data are presented to demonstrate that yields can be maintained with lower inputs when soil health has been maintained. It is also argued that substituting high inputs to mask the effects of poor soil health is very much against the development of more sustainable sugar cane farming systems.

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SESSION 3

ABSTRACT 8

Evaluating production strategies for sugar cane biomass using a crop model

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Keywords: Modeling, Energy Cane, Harvest Time, Row Spacing, Resource Use Efficiency

High energy prices relative to the sugar price make the utilization of sugar cane for ethanol production and co-generation more attractive than producing sucrose only. Growing sugar cane for maximum biomass, the key ingredient for energy products, requires a different production approach to optimally exploit environmental, genetic and capital resources, than that for producing maximum sucrose. Conducting field trials to determine the potential for biomass production and to identify best management practices is a costly and time-consuming exercise. A modeling experiment could produce valuable information quickly and point to areas that require further research and feasibility studies. This paper demonstrates such an attempt.

The Canegro model and long-term daily weather data are used to calculate the production of aerial biomass and its components (living leaves, dead leaves, stalk fibre and sucrose) for various permutations of harvest month (January to December), harvest age (9 to 15 months) and row spacing (0.6 and 1.4 m) for two resource scenarios in South Africa (dryland and irrigated). Simulated yields are compared with observed data from selected experiments and the literature. Biophysically-based explanations for trends and discrepancies are given and priorities for future research proposed. The potential of manipulating age of harvest and row spacing to maximise fibre and sucrose production rates at different times of the year are investigated. The use of a 20-year period of daily weather data enables investigation into the effects of year-to-year variation on these production parameters.

The economic value of sucrose and fibre yields expected from the different production strategies are calculated to give a broad indication of economic feasibility and production practices that are likely to produce best profits. The practical implications for agronomy and farm activities of these strategies are discussed, and future research priorities are highlighted.

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ABSTRACT 9

Tactical and operational irrigation scheduling in the Australian Sugar Industry

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Keywords: Modeling, APSIM, Participatory Action Research, Internet

Researchers and extensionists have expended a great deal of effort on irrigation science and practice over many years in order to

improve the timing and amount of irrigation to many crops, including sugar cane. Despite these efforts there is little evidence-based irrigation scheduling in the Australian sugar industry. This paper summarizes recent efforts in Australia to identify growers concerns and decision-making processes in order to develop a customized irrigation scheduling service provided over the Internet. The process started with a challenge from growers to scientists to use their modeling skills to produce more yield for growers from a limited amount of irrigation. A seasonal (tactical) irrigation scheduling system was developed using the APSIM-Sugarcane model. The computer (evidence) based schedule was compared with the growers 'gut-feel' system in replicated experiments over a period of three years. The computerized system produced a seasonal irrigation schedule similar to that of experienced growers and yield differences were minimal. The seasonal scheduling system was made available over the Internet but was seldom used because of its slow response. Simultaneous participatory research with growers in full irrigation schemes led to the development of a short term (operational) scheduling service over the Internet. The growers involved in the project rapidly adopted the prototype system because of its speed and simplicity. Growers with limited water still wanted the skill of the tactical APSIM-based service, delivered with speed and simplicity of the operational scheduling service. This paper describes the modeling work required to deliver a tactical and operational irrigation scheduling service to growers with limited and unlimited irrigation.

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ABSTRACT 10

The future of sugar cane modeling

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Keywords: Modeling, Decision Support Systems

Over the past few decades, sugar cane modeling, - and crop growth modeling in general - has contributed significantly to synthesise our understanding of crop-environment relations and to identify gaps in our knowledge, helping us to determine research priorities. Considerable efforts have also been devoted to develop model-based decision support systems assisting growers and other industry stakeholders, but with mixed results.

This discussion paper explores the future of sugar cane modeling. The appropriateness of modeling to address specific issues is discussed against four criteria: (i) the impact of the issue on the viability of the industry (ii) the (potential) contribution of modeling to resolve the issue (iii) the efforts required to realise the potential contribution, and (iv) the imminence of the issue. This reveals (obviously, in hindsight) that, rather than using computer models to assist decision processes that are reasonably well done without them (such as in most routine practices), models have the highest added value in areas where empirical knowledge is lacking and experimentation to generate such knowledge is very costly or even impossible. These include, for example, assessment of favourable traits of varieties that do not yet exist; impact of climate change, and supply chain optimisation. Model-based tools to assist growers in operational decision making will have their largest impact where growers must adapt to change, e.g. when facing restrictions regarding burning, water use or fertilisers. Difficulty in using such tools becomes a minor issue. Their relevance and usefulness must be ensured through close collaboration between researchers, modelers, farmers and advisers. The trends in strategic and operational decision support will be synergetic: strategic applications may attract considerable funds, but only after deriving credibility from the success of operational applications. Systems research will further shift from supply-driven to demand-driven from end-users and beneficiaries to tackle new issues and reduce uncertainties.

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SESSION 4

ABSTRACT 12

Innovative management of organic matter

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Keywords: Decomposition Rates, Soil Health, Environment

Three years of trials on the Quirk Farm in New South Wales, Australia, have shown that the decomposition rate of organic matter (OM) has been markedly accelerated by surface spray applications of small amounts of N (1.5Kg to 3Kg/ha.), simultaneous to a decrease in putrefaction following precipitation events. The accelerated decomposition of OM has been accompanied by a 90% increase in crop production and a 25% decrease in production costs. We are in the process of quantifying the above observations on OM decomposition, identifying the relevant processes involved and thereby innovating the current standard sugar cane farming system in Australia. We believe that if the processes that act on the decomposition of organic matter, including the cane trash and tops, and the sucrose deposited on them during harvesting, can be identified and managed and/or manipulated, a farmer will have a powerful tool to increase efficiency and to better protect or improve the environment. The treatment of residual OM is a core activity in most current farming systems. The treatment of OM dictates the timing of most other activities and directly impacts on crop establishment and productivity. Current farming systems are based around the management of direct and indirect OM issues, for example, seedbed preparation, germination efficiency, cultivation efficiency, harvesting operations, and nutrient availability. The timing of most farming activities are in fact dictated by the ability of the system to manage OM. In addition, the retention of the OM and its carbon in the soil, is known to have a direct impact on soil health and on micro-environments which in turn directly create conditions for minimising current inputs while at the same time increasing production.

The presentation will include photographs recording the various activities, the results of the trials and the effects that they have had on the micro/macro-environment and on soil health.

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ABSTRACT 3

Sustainability of sugar cane yield through organic farming

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Keywords: Organic Sugar cane, Vermiculture, Soil Fertility and Sucrose Content

Organic farming arose from the need to make agriculture more ecologically sound and to develop positive value systems among producers and consumers. With increasing health consciousness and concern for conservation of the environment, the demand for organically produced products has been growing steadily in developing countries. Studies were carried out at the Research and Development Centre, E.I.D.-Parry (India) Ltd., India, during 2001 - 2005 to develop packages for the organic sugar cane.

IFOAM (International Federation on Organic Agriculture Movements) basic guide-lines were followed for developing organic sugar cane. Seed materials were obtained from an organic nursery and was planted on uncultivated fresh land. A buffer zone was maintained between organic and conventional sugar cane to prevent possible contamination with chemicals/fertilizers.

Different kinds of experiments were conducted both in plant and ratoon sugar cane. In the first phase, bio-conversion studies were conducted using sugar cane industry by-products and sugar cane crop residues. These studies showed that the earthworm, Eudrilus eugeniae, performed better than other earthworm species in term of composting. Field trials were conducted to study the in-situ vermiculture in relation to organic sugar cane in plant and ratoon. Results of these field studies showed that in-situ vermiculture under organic cultivation produced the highest sugar cane yield of 166.5 and 164.3 t ha-1 in plant cane and ratoon, respectively, compared to inorganic cane yields of 118.6 and 113.3 t ha-1 in plant cane and ratoon, respectively. In-situ vermiculture produced the highest sugar yield. Application of biofertilizers (Acetobacter and phosphobacteria) with recommended organic nutrients produced 131 t ha-1.

The soil organic carbon content showed that in-situ vermiculture improved the soil organic carbon from 0.26% (before vermiculture) to 0.32% (after vermiculture). Similarly the improvement in available nitrogen content was recorded from in-situ vermiculture practice. Through the conversion to an organic system, the sustainability of yield and sucrose content in sugar cane could be achieved. Moreover increased ratooning may be possible due to improved soil fertility. Further, it will certainly help the soil health, food safety, environmental purity, and ecological balance.

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ABSTRACT 38

Effects of tropical legumes on nitrogen dynamics, carbon emission and on growth and nutrient content of sugar cane

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Keywords: Biomass, Chemical Fertilisation, Mineral N, Yield

Northeast Thailand is the main area of sugar cane production in the country. It is characterized as having low soil fertility, sandy texture soils, and long periods of drought during the growing season that cause low sugar cane yields. Green manure may be a soil amendment that could improve fertility, so the residues of leguminous crops including grain legume peanut (Arachis hypogaea L.), common green manure legumes, pigeon pea (Cajanus cajan (L.) Millsp.), sword bean (Canavalia gladiata (Jacq.) DC.) and sunnhemp (Crotalaria juncea), and two local leguminous weeds, Crotalaria striata and hairy indigo (Indigofera hirsuta) were investigated for their contribution to mineral N dynamics and C emission. Nutrient contents and growth of sugar cane were also investigated in pot experiments using the green manures and with mineral nitrogen application, as (NH4)2SO4, equivalent to 49 kg N ha-1.

The experiment was conducted in 28 L pots with two rates of legume residues. All the legume residues were added at a rate equivalent to 6.25 Mg ha-1, and only peanut, pigeon pea and hairy indigo residues were additionally added at a rate equivalent to 12.50 Mg ha-1. There were nine treatments with incorporation of legume residues, one treatment with chemical fertilizer N, and a non-treated control. All the treatments were replicated four times and received chemical P2O5 and K2O fertilizers at rates equivalent to 49 kg ha-1.

Peanut residues had good chemical quality for decomposition and N mineralization as they had high N concentration but low lignin and polyphenol concentrations as well as low C:N ratio. Mineral N was lower after adding peanut residues than with sunnhemp and chemical N fertilizer at 53 days after mixing of the soil with legume residues and chemical N fertilizer. After this period, mineral N was the highest in the treatment with the equivalent to 12.50 Mg ha-1 peanut residues.

Sugar cane biomass was highest with peanut residues equivalent to 12.50 Mg ha-1 but was not significantly different when peanut,

sunnhemp and C. striata residues were applied at the rate equivalent to 6.25 Mg ha-1 .On the other hand yield obtained from the 12.50 Mg ha-1 peanut residue treatment was significantly different compared to those of other treatments including that with chemical N fertilizer.

The peanut residues resulted in the highest levels of N, K and Mg in the sugar cane plant, while the hairy indigo gave the highest P content and chemical N fertilizer the highest Ca content. CO_2 emission was significantly higher after adding legume residues than with mineral fertilizer N. The emissions increased with rates of residue incorporation. Pigeon pea residues at 12.50 Mg ha-1 showed the highest CO_2emission.

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ABSTRACT 37

Minimum tillage: ten years of experience

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Keywords: Soil Degradation, Productivity, Economic Analysis, Nitrogen Fertilizer

Many of the sugar cane growing soils in Thailand are undergoing structural degradation after being planted with sugar cane for long periods of time with the associated continuous and intensive land preparation involved. In addition, cane burning, together with the introduction of heavy cane harvesters, loaders, and heavy trucks have all contributed further to the break down of soil structure. Minimum tillage has been proposed as an alternative practice to reduce loss of soil productivity. Long-term effects of various sugar cane land preparation techniques have been studied since 1994/95 at Suphanburi Field Crops Research Center. The five tillage systems tested were: T1 conventional tillage, T2-T4 minimum tillage with different planting methods, and T5 no tillage. Soil physical properties and cane yield were monitored over time. The minimum tillage treatment that used only a ripper between the row gave higher yields than the conventional and no-tillage treatments, with the latter showing the lowest yield. Cane in all tillage treatments did not show any significant response to nitrogen fertilizer. When considering the economic analyses, minimum tillages gave the best net profit compared to that of conventional tillage.

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ABSTRACT 11

Should nitrogen fertilizer be managed differently following trash blanketing?

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Keywords: Environment, Mineralization, Immobilization, Decomposition, Crop Modeling.

Trash contains substantial amounts of nitrogen (N), mainly in organic form. So the trend towards green cane harvesting and trash blanketing will greatly affect N cycling and, possibly, N fertilizer management. Ideally, the impacts on N fertilizer management would be identified by long-term trash blanket presence x N fertilizer rate experiments. However, these experiments do not exist and so a simulation study of the interactions between trash blanket presence and N fertilizer application rates was undertaken. Long-term (100 years) simulations were conducted with the APSIM-Sugarcane cropping systems model for three different soil types combined with climatic data from five locations in the Australian sugar industry. All simulations were initialized by having no trash blanket and with industry average N management in the first 20 years, to represent the transition from a trash burning to trash blanketing. In the first 5-10 years with trash blankets, simulated sugar cane yields were reduced by trash retention at many rates of N due to the immobilization of N by decomposing trash. Following this period, when trash-soil-crop N cycling was more at equilibrium, average yields of ratoon crops were increased by trash blankets. This result agrees with general experience in Australia and was mainly due to increased soil moisture with trash blankets in the simulations. The same rates of N were needed to give maximum yields, both with and without trash blankets. For plant crops, maximum yields were similar with and without trash. However, with trash maximum yields occurred at markedly lower rates of N fertilizer due to increased mineralization of N during the fallow that preceded planting in the simulations. These simulation results not only have implications for developing N fertilizer management guidelines for trash blanketed systems, they also indicate that care is needed when interpreting the results of short-term trash management experiments.

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ABSTRACT 21

Comparison of nutrient sources for mineral nutrition of florida sugar cane

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Keywords: mill mud, green manure, fertilizer, organic matter

Improving soil organic matter and soil fertility are important factors in the sustainability of sugar cane production on mineral soils. A

trial was established in 2004 on a sandy Spodosol in Florida to compare the effect of organic and inorganic nutrient sources on soil fertility and sugar cane production. The three nutrient sources, compared in a 3x2x2 factorial experiment in a split-split plot design, were:

Mill mud (chacaza) applied at sugar cane planting (0 or 224 tons/ha), Cropping system prior to sugar cane (soybean as green manure, soybean with above-ground biomass removed for forage, and weedy fallow), and Inorganic fertilizer (0 or commercial rate). The addition of mill mud prior to planting significantly increased soil pH, P, K, Ca and Mg (sampled at plant cane harvest), while the combination of mill mud following soybean green manure translated to higher soil test values of P, K, Ca, Mg, Si and Fe than mill mud alone. The application of mill mud, green manure and inorganic fertilizer all significantly raised plant cane stalk number, stalk weight, tons of cane per hectare (TCH) and tons of sucrose per hectare (TSH) compared to unfertilized controls. However, the below-ground biomass retained in the forage soybean plots did not provide a sugar cane yield benefit. The addition of green manure or fertilizer resulted in an increase of 22 TCH and 2.7 TSH, whereas mill mud increased yields by 54 TCH and 5.4 TSH. A significant mill mud x fertilizer interaction indicated that fertilization was not required if mill mud was added to plant cane, at treatment rates. In general, adding mill mud to green manure or fertilizer inputs always improved yields, but adding green manure or fertilizer to mill mud provided little additional benefit to plant cane. Results from tissue analysis of the plant crop and the first ratoon crop yield results will also be discussed.

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ABSTRACT 20

Filter cake applied on top of the cane row and between rows in ratoon cane

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Keywords: Residues, Organic Fertilizer, Phosphate Source, Sugar Cane Yields

The residues produced in great amount by the sugar cane agribusiness have been largely used as an organic fertilizer in substitution of the mineral fertilizer, with impact on yield and cost. This work had the objective to evaluate the efficiency of different doses of filter cake on sugar cane yield and quality of the second ratoon cane (cv. SP81-3250). The experiment was carried out in the Jalles Machado sugar-mill, located in Goianésia (GO) and the soil was a Red Yellow Latosol. The wet filter cake rates used were 0, 10, 20, 40 and 80 t ha-1 in two different application methods: on the top of the cane plant and buried in between the two cane rows. The experiment was a randomized block in factorial design (2 x 5) with five replications. The filter cake rates necessary to achieve the Technical Maximum yield (DMET) and the Economical Maximum Return (DMEE) were calculated from the sugar yield and costs of application of the filter cake. The application of the wet filter cake provided increase in cane and sugar yields. The application methods (on the top of the cane row and between cane rows) did not differ between themselves when growth variables, production and quality of the cane were analysed. The filter cake rates necessary to achieve DMEE were 57,3 and 59,9 t ha-1 for cane and sugar yields respectively.

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ABSTRACT 13

Mulching press mud for controlling weeds and increasing productivity

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KeyWords: Dry Matter, Cane Yield, Weed Competition, Herbicide Control

Weed competition has been recognized as one of the major causes of low productivity in south India. Sugar cane remaining in the field for more than 12 months and the slow rate of growth at the initial stage result in increased weed problems. Weed infestation up to 120 days after planting of sugar cane was found detrimental to final yield. Hence, managing weed free soil is essential for increasing cane yield. Experiments were conducted at a farmer's field with different mulching materials including cane trash, press mud (sugar mill waste) and live mulch (intercropping with cow pea). Mulching was also compared with herbicide control and the farmer's practice of hand weeding twice.

Organic materials proved to be the best mulch and they are locally available. Press mud was the next best to chemical spray in reducing weed number and weed dry matter at every stage of growth. Under water scarcity conditions, mulching with cane trash in between the rows produced less weed competition and increased cane yield. Press mud and trash mulching reduced weed infestation by 70 and 42% over the unweeded check at 30 days after planting. Though germination and tiller production at the initial stages were low due to mulching, optimum population of millable cane could be achieved at later stages with the utilization of press mud as a nutritional source. Spreading press mud in between the rows at 37.5 tonnes ha-1 increased yields by 13 and 11 % when compared to hand-weeding twice and herbicide application, respectively.

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ABSTRACT 34

Responses of sugar cane to irrigation application at different growth stages on a clay soil

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Keywords: Irrigation Period, Crop Establishment, Vegetative Growth, Yield Formation

Timing of irrigation in relation to crop maturity directly affects yield and cost of sugar cane production. Responses of a sugar cane variety to eight irrigation periods were examined on a clay soil at Chai Nat Field Crop Research Centre from 2001 to 2003. Irrigation periods throughout the growing season were between 0 and 295 days and were made during crop establishment, vegetative growth, and yield formation . Leaf area index and crop growth rate increased with increasing irrigation periods. Irrigation at crop establishment, vegetative growth, and at yield formation increased yields by 11.1-14.5, 22.9-23.2 and 8.1-9.1%, respectively, compared to no irrigation which yielded 87.1-98.6 tonnes ha-1. Irrigation applied during the periods of crop establishment and yield formation produced 29.1-34.4% greater yields than with no irrigation. Greatest yields, however, were found with irrigation applied during the periods of crop establishment and vegetative growth, or vegetative growth and yield formation, or from crop establishment to yield formation. These irrigation periods showed no significant differences in yields among themselves, but they produced 43.3-57.2% higher yields than with no irrigation. Stem height, stalk number and stalk/stool were the major yield components determining yield increases associated with length of irrigation periods. Sugarcane grown in this area, particularly on a clay soil, should be irrigated during the periods of crop establishment and vegetative growth. This irrigation period lasts 170 days, which is shorter than that between vegetative and yield formation, or between crop establishment and yield formation.

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ABSTRACT 32

Sodic soil management in the western sugar cane area in Thailand

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Keywords: Sodium, Soil Amendment, Yield, Millable Cane, Minimum Tillage

Sodic soil is widely spread throughout the western part of Thailand. The high concentration of sodium in the soil adversely affects the root and aboveground growth of sugar cane. Severe sodicity even causes death of cane. Management of sodic soil in this area was studied on the cane farm of Mitr Phol Sugarmill, Danchang, Suphanburi, from 2003 to 2005. The experiment was a split-plot design with four replications. Main plots were three different soil management practices (flooding, deep tillage and minimum tillage). Sub-plots were six different soil amendments (filter cake, mill ash, compost, gypsum, dolomite and rice husk) and one control with no amendment. Results indicated that minimum tillage with any type of soil amendment gave higher cane yield and number of millable canes, both in plant and ratoon cane. There was no difference in cane yield among the different types of soil amendments. However application of 37.5 t ha-1 of filter cake (dry weight) tended to give higher yield and quality of cane. Minimum tillage gave the best yield returns and the best profit margin.

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SESSION 5

ABSTRACT 15

The better sugar cane initiative - impacts and benefits on the global sugar cane industry

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Key words: Sustainability, Environmental Impacts, Cane Growing, Sugar Milling, Better Sugar Cane

An international conference in London in June 2005 confirmed that producers and processors of sugar cane were committed to the common goal of undertaking production and processing of sugar cane in an environmentally, socially, and economically sustainable manner. This goal will be met through the Better Sugarcane Initiative (BSI). Stakeholders will be engaged in a constructive dialogue to define and develop relevant performance-based and verifiable standards to describe practices within the value chain for sustainable sugar cane systems. The BSI will also foster implementation of improved management practices to effect measurable reduction in key impacts, as there is evidence that more sustainable practices can result in improved profitability.

To achieve this goal the participants in the BSI have agreed:

- To maintain open, honest, and respectful communications;
- To develop a protocol for external communications related to the Better Sugarcane Initiative including the use of sensitive data;
- To respect differences in experience and opinion, recognizing that impacts will differ from farm to farm and region to region, as will the ability to reduce impacts;

- To form a steering committee that reflects the interests of the range of stakeholders interested in Better Sugarcane;
- The key global impacts associated with growing and processing sugar cane could be addressed in the following areas:
    - Field environmental impacts associated with soil health, water use, generation of effluents and habitat loss;
    - Labour issues were ranked as work place health and safety, child labour, casualisation of labour and wage levels;
    - Community impacts included access to water, health and education;
    - Processing impacts were ranked as food and worker safety, mill environmental issues and water use.

The presentation provides background to the BSI, how it may impact on the international sugar cane industries and plans for the initiative. The authors of the paper draw on their international experiences and knowledge to inform the workshop as to BMP in their countries of origin and associations, and will look for assistance from the workshop participants to broaden this knowledge, for the betterment of the global sugar industry.

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ABSTRACT 16

Sustainable sugar cane farm management system (susfarms): an innovative approach to environmental management of sugar cane in South Africa

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Keywords: Principle, Economic, Social, Best Management Practices.

In response to human-induced impacts on the world's water resources, the World Wildlife Fund (WWF) established its Global Freshwater Programme which has three targets:

- Protecting and managing wetlands.
- Conserving and restoring the ecological processes of river basins.
- Changing policies and practices of government, business and agriculture.

The WWF in conjunction with its South African based Mondi Wetlands Project (MWP) formed a partnership with the Noodsberg Cane Growers (NCG) in 2004 to encourage sustainable sugar cane production through the implementation of better environmentally friendly management practices. The result is improved land use practices and less impact on freshwater systems. The project known as the Sustainable Sugar Initiative (SSI) aims to produce a practical, workable, sustainable and acceptable environmental management system for sugar cane. The Noodsberg Cane Growers have progressed significantly towards the implementation of an Environmental Management System (EMS), based on ISO 14001, over the past eight years. During 2004 and 2005, the Noodsberg Cane Growers in partnership with WWF/MWP reviewed the existing EMS in order to take the implementation further in a way that was simple to implement and practical in its effect.

An innovative approach, using principles, criteria, indicators and verifiers/guidelines which support relevant international and South African legislation and which are applied by means of Best Management Practice (BMP), is described. The definitions of the principle, criterion, indicator and verifiers/guidelines are given. Three main principles make up the major framework of this new sugar cane farm management system. They are:

- Economic principle - economically viable sugar cane production is maintained or enhanced.
- Social principle - the rights of employees and the local community are upheld and promoted.
- nvironmental principle - natural assets are conserved, critical ecosystems are maintained and agricultural resources are used sustainably.

The modules making up the new EMS are described and include an audit check sheet for growers (self audit) and an audit check sheet for auditors (certification audit).

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ABSTRACT 17

Losses of farm chemicals from fully irrigated sugar cane systems in Australia

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Keywords: Environment, Nitrogen, Herbicide, Furrow Irrigation, Crop Modeling.

There is much concern about environmental impacts of agriculture, dominated by horticulture and sugar cane production, in catchments draining into the Great Barrier Reef lagoon in Australia. Sugar cane in the Burdekin region stands out from other crops/regions because it is fully irrigated, and the irrigation may enhance the losses of chemicals from farms. Too few measurements of chemical concentrations in the local water bodies and losses from farms exist to develop management recommendations for minimising environmental impacts of sugar cane production. To allow the formulation of these recommendations, water, herbicide and nitrogen (N) losses have been monitored at three sites in different parts of the Burdekin region. Chemical losses were lower than expected for the 2004-2005 crop. N losses in runoff were ~3 % of N fertiliser applications, and losses in deep drainage were ~9 %. The concentrations of the herbicides atrazine and diuron in runoff were lower than the ANZECC guidelines in all runoff events. The data were used to parameterise the APSIM-Sugarcane cropping systems model, and the model used to explore possible management strategies to reduce N losses. The model was able to predict crop yields, and fluxes of N and water in both runoff and deep drainage. At one site, the modeling identified that the crop had been under-irrigated during spring 2004. If this crop water stress had been avoided the yield predicted could have increased by 25%, with the crop taking up more N and N losses in deep drainage decreased. At another site interactions between the timing of irrigation and N fertiliser were investigated, suggesting that 20-50% reductions in N losses in runoff would have been possible by delaying N applications. However, delays increased the probability of increased losses following summer storms. The results indicate that production and environmental win-wins may be possible with fully irrigated sugar cane systems.

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POSTER SESSION

ABSTRACT 18

Integrated weed management: strategies to reduce costs and amount of herbicides in the Mauritian sugar cane industry
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Keywords: Amicarbazone, Trifloxysulfuron, Ametryn, Critical Periods Of Weed Competition, Mechanical Weeding

In Mauritius, weed control in sugar cane is achieved quite successfully by application of two or more herbicide treatments often complemented by some manual weeding. However, the average annual weed control costs per hectare exceed US$ 200; some growers in the humid areas even spend more than US $ 500 per hectare on this operation. The average amount of active ingredient used per season has decreased within the last fifteen years but still represents more than 7 kg a.i. ha-1. A project to develop integrated weed management strategies was initiated in 1998; the main objectives were to reduce the amount of herbicides and labour. The integrated approach designed is based upon the critical periods of weed competition. Field studies have shown that, in the worst scenarios, weed competition started six to eight weeks after planting or harvest (WAP/WAH) and ended between 20 to 28 WAP/WAH. Field trials have also revealed that the upper limit of the critical periods can be reached four or more weeks earlier if cane is planted in 'Dual Rows' (high density planting). In plant cane, mechanical weeding would cost-effectively replace at least one herbicide application while adoption of green cane trash blanketing (GCTB) would be advantageous in ratoon cane. Where GCTB is not possible, the new approach recommends delaying the traditional first pre-emergent herbicide treatment until onset of the critical periods; a new pre- and post-emergent herbicide treatment consisting of a tank-mix of amicarbazone and trifloxysulfuron+ametryn has been found to provide excellent control of almost all emerged weeds with a relatively long residual activity. Preliminary results have shown no significant increase in weed seedbank with this weed management approach which has now been recommended to the growers.

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ABSTRACT 5

Agronomic practices for better ratoon yield
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Keywords: Stubble Shaving, Trash Removal, Burning, Setts, Cane Yield

Ratoon crops account for a sizeable share in total sugar cane production in India, accounting for more than 30 per cent of total production. The lower productivity of ratoon crops drastically affects the national average yield. Compaction of soil immediately after harvest produces loss of soil structure, impeding development of the ratooning crop which ultimately leads to reduced yield potential. Moreover, because of apical dominance, the topmost buds of the plant stubble often failed to root in the soil thereby causing gaps in the field. Experiments conducted on small scale farmers' holdings revealed that agronomic practices like trash removal, stubble shaving and filling gap with polybag grown setts could enhance cane and sugar yields considerably. Post-harvest trash removal and stubble shaving together realized 32% increase in initial shoot population over the existing practice in these experiments, namely burning trash after harvest of plant crop and no stubble shaving. The latter eliminated the deleterious effect due to apical dominance and allowed better rootingand vigorous growth of tillers . Better establishment of polybag grown seedlings filled in the gaps alone increased juice quality by allowing development of a homogenous population of stalks resulting in uniform maturity. Stubble shaving after post-harvest trash removal and filling the gaps with polybag grown setts were found to be a more effective combination, found to be more ff increasing final cane yield by 23%. Sugar yield followed the same trend as cane yield and increased by 32% over control.

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ABSTRACT 19

Dissemination of "Seedling transplanting technique in sugar cane" to cane growers through Demonstration and Training

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KeyWords: On Campus, Knowledge, Skill, Saving Seed

The sprouted sett transplanting method is one newly implemented technology in India . This method permits faster multiplication and the saving of 75 percent millable cane ordinarily used as seed material. Sprouted setts produced from single buds in nurseries are transplanted in the main field at recommended spacing of 80 cm. On-campus training and on-farm demonstrations were conducted by the Regional Research Station, Tamil Nadu Agricultural University to teach farmers how to implement this planting method. The program was sponsored by the Tamil Nadu State Council for Science and Technology. The training modules were prepared to benefit the trainees in terms of social, economical and environmental aspects. The training schedule involved the expertise of inter-disciplinary scientists to strengthen the technical aspects. Faculty scientists delivered lectures on varietal suitability, organic and inorganic nutrient management, weed management and pest and disease management during the training programme. This had inculcated interests and motivated trainees to enrich further the information. The two-way lecture discussion methods helped farmers understand the content of the training in a precise manner. In all the practical sessions, "learning-by-doing" method was used to create trainees' confidence. The trainees were evaluated (pre-, concurrent and post-evaluation) to assess the impact of the programme on their performance. The evaluation showed that the trainees were able to gain significant functional knowledge and operational skill in performing the series of steps in setts transplanting on commercial basis.

The trainees were given reading material on the method. The programme helped to create awareness among the farmers to acquire sufficient knowledge and skill to adopt this new practice.

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ABSTRACT 22

Diclosulam: a new pre-emergence herbicide to substitute for atrazine in sugar cane

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Keywords: Atrazine, Tank-mixes, Weed Control

Atrazine has been used continuously over the past 40 years for pre-emergence control of broad-leafed weeds in sugar cane in Mauritius. Alternatives to atrazine are being tested, as several cases of weed resistance to this herbicide and contamination of underground water have been reported in the literature. Diclosulam (trade name Strongarm), is a new acetolactase synthase enzyme (ALS) inhibitor and has been evaluated at rates varying between 0.06 and 0.25 kg a.i. ha-1 for general weed control in sugar cane. In initial trials, diclosulam, at rates above 0.15 kg a.i. ha-1, provided a broad spectrum of control, including for some annual grasses, and a residual activity over 16 weeks after spraying (WAS). However, at these rates, it caused an adverse effect on cane growth. Subsequent trials, in plant and ratoon cane, revealed that diclosulam, at rates varying between 0.06 and 0.08 kg a.i. ha-1, was more effective than atrazine at 4.0 kg a.i. ha-1 12-16 WAS and was well tolerated by sugar cane. Furthermore, tank-mixes of diclosulam with grass herbicides such as acetochlor, oxyfluorfen, tebuthiuron and hexazinone proved to be superior to atrazine with the same partners. In post-emergence situations, tank-mixing diclosulam with 2,4-D amine salt did not show any additional synergistic effect over atrazine. Diclosulam at 0.06 and 0.08 kg a.i. ha-1 has been recommended as a substitute to atrazine in all standard tank-mixes.

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ABSTRACT 24

Estimation of root distribution based on growth direction of shoot roots in sugar cane (Saccharum hybrid spp.)

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Keywords: Root Length Density, Shoot Root Direction, Soil Depth

A deep root system is known to be more advantageous than a shallow root system because it makes access to groundwater easier for plants. Thus, a deep root system is a desirable characteristic of sugar cane varieties especially in dry areas. It needs tedious procedures to investigate the distribution of root system. We paid attention to growth direction of the shoot roots, one of the major factors determining distribution of root system. In this study, we discussed whether distribution of the root system could be estimated by growth direction of shoot roots, which can be easily investigated using mesh cylinders. Variety 97S41 with a deep root system and Variety NiF8 with a shallow root system were used, 97S41 is a high biomass line in drought area and NiF8 is a leading variety in Japan. Distribution of root system was evaluated as the density of root length in every 30 cm soil depth layer down to 150 cm below the ground. Root length was measured by the modified line intersect method. Growth direction of shoot roots was evaluated using mesh cylinders made of wire netting, 30 cm diameter and 30 cm deep, marked at every 3cm depth layer, and the ratio of roots passing each 3 cm layer to the total root number was calculated. 97S41 had significantly larger root length densities than NiF8 in the deep soil layers such as at 90-120 cm and 120-150cm. For growth direction of shoot roots, 97S41 had higher ratio of roots in lower

layers of the cylinders, whereas NiF8 had higher ratio in upper layers. This indicates that the growth direction of shoot roots was more vertical in 97S41 and more horizontal in NiF8. Although further investigations with more varieties and environmental conditions are needed, the present study suggests that it may be possible to estimate the distribution of root system roughly through the growth direction of shoot roots.

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ABSTRACT 25

Nitrogen accumulation by sugar cane and its potential as a feed

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Keywords: Nitrate, Nitrogen Fertilizer, Cleaning Crop, Sorghum

To cope with an increased demand for livestock products in Japan, a greater number of cattle is being raised per farm. Feed production on the other hand has not increased, therefore resulting in a greater dependence on imported feed. As a high biomass-yielding crop, sugar cane has the potential of taking up a large amount of nitrogen and when fed to livestock, it could improve the nitrogen cycle at the local level. In this study, we carried out a field experiment to evaluate nitrogen uptake and biomass accumulation by sugar cane (variety KRSp93-19) in comparison to one sorghum variety when high rates of nitrogen were applied. We also measured nitrate concentration in the harvested components of the plants to assess their suitability as feed. From the harvest data, as high as 348 kg N ha-1 accumulated in the aboveground parts of the sugar cane when 450 kg ha-1 of fertilizer N were applied. Nitrate concentration of both leaves and stems of the sugar cane was negligible irrespective of the nitrogen rates used (50 kg ha-1 to 450 kg ha-1). Sorghum stems on the other hand contained significant amount of nitrate especially when high doses of fertilizer nitrogen were used. On the basis of this experiment alone, sugar cane seemed to be suitable for feed as well as for mopping up nitrogen in sites where this nutrient has accumulated. Further experiments need however to be conducted to confirm the results of this study.

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ABSTRACT 26

Evaluation of changes in physico-chemical properties in soils under sugar cane or rotation cropping, and in non-cultivated soils in Haft-Tappeh, Iran

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Keywords: Potassium Fertilization, Irrigation, Clay Alteration, Fixed Potassium, Leaching

Sugar cane fields and those under rotation crops have been cultivated without potassium (K) fertilization in Iran for 42 and more than 100 years, respectively. Sugar cane fields receive approximately 30,000m3 ha-1 irrigation water while the rotation crops receive 10,000m3 water ha-1 annually. We hypothesized that there may have been some alteration in physico-chemical properties of these soils compared to non-cultivated fields situated nearby the above fields as a result of the long duration of cultivation and effects of the high annual application of irrigation water. The objective of this research was to evaluate the physico-chemical properties of the soils with emphasis on changes in the different forms of soil potassium. Both gypsum and calcium carbonate levels were lower in the surface soils of cultivated fields as a result of leaching. Uptake of potassium by crops, along with its leaching, resulted in the modification of the illite clay fraction into expanding clay minerals in the surface soils of cultivated fields. The above result was supported by X-Ray diffraction studies and by changes in physico-chemical properties with special reference to an increase in CEC and level of K fixed in the clay lattice. Fixed K in soils under rotation cropping did not show any different trend as compared to soils of uncultivated fields. Nevertheless it decreased in sugar cane cultivated soils, especially in the Ap horizon.

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ABSTRACT 27

Comparison of two trash incorporators to solve the post harvest burning problem

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Keywords: Nitrogen, Disc Harrow, Rotary Hoe, Sugar Cane Yields

A field experiment was conducted to evaluate methods of post-harvest trash incorporation and rates of nitrogen (N) fertilizer in ratoon cane . A notched blade disc harrow and rotary hoe (middle knives removed) were compared with trash burning after harvest in the management of post-harvest residues. Three rates of N fertilizer (94, 188 and 281 kgN ha-1`) were applied in the trash management treatments. The notched blade disc harrow, with trash incorporated between cane rows, gave better yields in the first ratoon than did the rotary hoe. The rotary hoe can successfully incorporate cane trash only after previous use of the notched blade disc harrow. There was better growth and more tillers in the trash incorporation treatments in the first ratoon crop, three months after

the incorporation, than in plots where trash was burnt. Trash incorporation treatments also had lower infestations of cane stem borer and weeds. Trash incorporation, by both machines, was associated with higher cane and sugar yields than trash burning in the first ratoon crop. Average cane and sugar yields of the first ratoon for notched blade disc harrow, rotary hoe and burning were 103.1 t ha-1, and 15.0 t ccs ha-1, 116.3 t ha-1 and 17.5 t ccs ha-1 and 76.9 t ha-1 and 10.6 t ccs ha-1 respectively. Nitrogen application at the rate of 188 kg ha-1 is recommended where trash is incorporated. The results also showed that ratoon cane with trash burning needs more nitrogen fertilizer than without trash burning. Trash conservation by incorporating not only solves the stool burning problem but also reduces nitrogen application to ratoon cane. Results in the second ratoon crop were similar to the first ratoon.

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ABSTRACT 28

Impact of root cutting management and nitrogen application on yield of sugar cane ratoon in sandy soil

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Keywords: Millable Cane, Nitrogen Rate, Post Harvest Root Cutting

A field experiment was conducted on a Warin series soil (fine-loamy, siliceous isohyperthermic Oxic Paleustults) in Northeast Thailand from 2003 to 2005, over a plant and two ratoon crops of sugar cane. The trial was designed to investigate the impact of post-harvest root cutting and rate of nitrogen application on millable cane yield of sugar cane variety Khon Kaen 1. Root cutting involved cutting-away from either side of the stool, some 15-20cm from the centerline of the row with discs, to a depth of approximately 16 cm to prune old roots and to disturb surface soil for improved infiltration of water. Treatments included a combination of nitrogen rates (0, 56, 112 kgN ha-1 compared to farmer's practice, 94-94-94 kg of N-P2O5-K2O ha-1) and the comparison of root cutting and conventional practice (control). Root cutting resulted in a 12.5 % increase in cane yield, over the control in the first ratoon crop, but there was no response in the second ratoon. The highest millable cane yields, 69.8 and 19.0 tha-1 in first and second ratoon crops respectively, were associated with application of 112 kgN ha-1. The sharp yield decline of approximately 74 % from first to second ratoon was due to reductions in the number of millable canes as well as in height and diameter of stalks.

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ABSTRACT 35

The response of sugar cane to six irrigation rates on a clay soil in Thailand

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Keywords: Growth, Evaporation, Yield

One major factor determining growth and yield of sugar cane is soil moisture availability. Six irrigation rates, namely IW/E (the ratio of irrigation water to evaporation) 0.0, 0.4, 0.6, 0.8, 1.0 and 1.2, were applied and the responses in growth and yield of two sugar cane varieties on a clay soil at Chai Nat Field Crops Research Center were recorded during the 2000-2003 growing seasons. The responses of the two sugar cane varieties to irrigation rates were similar with no significant difference in yield between them at each irrigation rate. The control treatment (IW/E of 0) gave a yield of 88.9-107.1 tonnes ha-1. Irrigation at IW/E 0.4, 0.6, 0.8, 1.0 and 1.2 increased yields by 18.0 to 41.2%, 21.2 to 40.9%, 22.8 to 40.1% and 22.1 to 46.7%, respectively, when compared against the control (no irrigation). Treatment IW/E 1.2, however, gave no significant difference in yield when compared to IW/E 0.6 to 1.0. Stalk height, stalk number, stool number and stalk/stool were major yield components determining yield differences among irrigation rates. Percent Brix, Polarization, Fiber and CCS were not significantly different among irrigation rates.

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ABSTRACT 33

A proteomic approach to analyze drought tolerant proteins in sugar cane leaf

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Keywords: Polyacrylamide Gel Electrophoresis, Mass Spectrometry, Protein Pattern

Sugar cane (Saccharum spp.) is one of the most important industrial crops in Northeast Thailand. However, as the yield of sugar cane is low due to poor ratooning ability, the cost of its production is high. To raise the yield, we believe that drought tolerant proteins in sugar cane must be understood to help identify the physiological traits that could be incorporated into the breeding program for drought tolerance in sugar cane lines. Drought tolerant proteins were consequently studied in two cultivars, K86-161 (a drought tolerant cultivar) and KhonKaen 1 (a drought susceptible cultivar) by two-dimensional polyacrylamide gel electrophoresis (2D-PAGE) and by mass spectrometry. The results showed that more than 300 protein spots could be detected in both cultivars by computer analysis, 100 of them being found in both sugar cane lines. Thirty-two protein spots were on the other hand only expressed in K86-161. Eighteen protein spots were up-regulated in the leaf of the drought tolerant sugar cane, while 45 protein spots were down-regulated. They were identified by mass spectrometry and sequential database analysis and their biological functions include

photosynthesis, DNA and protein synthesis, oxidative stress processes, cell elongation and lignification. Two of the identified proteins (actin depolymerizing factor and nucleoside diphosphate kinase II) may be directly involved in the drought tolerance phenomenon.

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ABSTRACT 39

Modified nitrogen guidelines for the Australian sugar industry

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Keywords: Nitrogen Mineralisation, Sugar Cane, Organic Carbon

Recommended rates for nutrient application to sugar cane in the Australian industry have traditionally been very general in nature. They have been based on results of yield-calibration trials that were averaged across districts and soils. Recent advances recognise that differences in soil properties need to be taken into account when determining appropriate nutrient-management practices on-farm.

As a result, nitrogen (N) fertiliser recommendations have been adjusted according to a district yield potential and a N-mineralisation index. District yield potential is defined as 1.2 times the highest recorded annual yield (t cane/ha) over the past 10 years. Using an estimate previously developed by Australian scientists, we set the baseline N application at 1.4 kg N/tonne for cane yield of up to 100 tha-1 and 1 kg N/tonne thereafter. For example, 160 kg N/ha are required when a district yield potential is estimated at 120 t/ha. The amount of N that can potentially be mineralised by the soil is then subtracted from this baseline N requirement. This mineralisable N is dependent on soil type. Easily mineralisable N is well correlated with organic carbon (Walkley-Black). This allows organic carbon to be used as a surrogate measure of the mineralisable N. Such organic carbon analyses are often included in the routine testing of soil samples conducted by commercial laboratories that service the Australian sugar industry.

With the promotion of legume fallow crops in the farming system, N derived from these crops also needs to be accounted for in the N recommendations. This can be done from the results of N-rate trials following fallow crops. We also recognised that N application rates should be modified when mill by-products have been used.

Based on these considerations, we have developed the following general relationship:

Appropriate N rate = N_a- N_b - N_c

Where, N_a is the base-line N requirement, which is determined from the district yield potential;

N_b is an estimate of the N mineralised from soil organic matter and is based on the N mineralisation index;

N_c is the N from other sources (fallow crops, mill by-products, etc).

These advances ensure that the modified N guidelines are soil, crop and region specific. They also take into account other sources of N within the sugar cane production system. Importantly, our modified guidelines are aimed at sustainability, with a focus on productivity, profitability and environmental responsibility.

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ABSTRACT 40

Soil loss and declining sugar cane yields on sloping land in Fiji

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Keywords: Erosion, Trash Mulch, High Rainfall, Best Practices

The growing of sugar cane on sloping land receiving high intensity rainfall causes extensive soil erosion in Fiji. This soil loss and accompanying declining cane yields on the undulating terrain is of major concern to the Fijian sugar industry. In recent years the growers have not only abandoned best management practices to conserve the soil but they have also uprooted the border crop vetiver grass that was planted at the time of expansion of the cane belt. This, to a large extent, has accelerated the loss of top soil and thus soil degradation causing, with the burning of trash, the yield to decline even more rapidly.

As quantitative data on erosion from field plots are scanty in Fiji, an experiment was initiated on a sloping cane farm (8o slope) to determine soil loss under different management practices and its impact on the cane yield of the plant cane and ratoon crops. The different management practices studied were sugar cane planted across slope, sugar cane planted uphill and downhill, trash cover with cane planted across slope and cane across slope with vetiver grass grown as hedgerow. Significant ($P < 0.05$) responses in cane and sugar yields of the plant cane crop were found but this was probably due to the increased length of planting within a treatment-plot rather than to best management practices used. In ratoons, no significant response to the best management

practices adopted was found. However, in plots in which trash was conserved and cane planted across the slope higher yield tended to be obtained compared to other three treatments.

Soil loss was largely affected by the different planting strategies associated with the conservation practices. Trash acted as a buffer under high intensity rain with the result that only 153 and 221 kg soil ha-1yr-1 were eroded in the first and second ratoon crops, respectively. Where the sugar cane was planted uphill and downhill soil losses were 16 376, 259 and 2274 kgha-1yr-1, in plant cane and in the two succeeding ratoon crops, respectively. The very low soil loss in the first ratoon crop could be attributed to the drought conditions prevailing that year.

Planting sugar cane across slope and conserving trash mulch therefore reduces soil erosion and with increasing period of cultivation will sustain cane production to provide stable economic return to the farmers.