SUGAR PRODUCTION: INTEGRATION AMONG SUGAR, ALCOHOL, RESIDUE CYCLING AND SUSTAINABILITY—A REPORT ON THE 2009 AGRONOMY WORKSHOP

By

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Abstract

THE 2009 Agronomy Workshop was held from 24 to 28 May 2009 in Uberlandia, Brazil. It was attended by some 70 participants with 22 of them travelling overseas from 13 different countries. The workshop was a success with 33 oral presentations (and 16 posters) spread under the following five specific themes: new technologies for sustainable sugar cane production, ratoon yield decline and its management, modelling sugarcane growth and production, soil and plant residue management, and the challenge of environmental pressure and strategy for the sugarcane grower. The workshop was also an opportunity to gain an insight into the sugar industry in Brazil, in particular the cultural practices adopted and the status of research and development in the country. The workshop has served as a reminder to technologists that optimising sugarcane production requires high quality seed to establish the plantation and the adoption of an integrated approach to the management of the crop. This integrated approach to optimise or enhance productivity includes the adoption of the most suitable technology in irrigation, fertilisation, weed management and crop protection. Though it is accepted that a sustainable sugarcane production system lies in soil organic matter conservation, particularly through green-cane harvesting, the management of the residues to avoid loss in productivity still needs to be researched. There will be no universally applicable residue-management system, and each system will need to be tested under the specific conditions prevailing locally. With the rising demand for higher fibre cultivars for cogeneration and ethanol synthesis, research and development in sugarcane agronomy will be increasingly focussed towards optimising the partitioning of the biomass in favour of fibre. The workshop has also created awareness that research and development initiatives will not attain the objective of enhanced productivity if social and organisational constraints impacting negatively on agronomic practices at field level are not addressed.

Introduction

The 2009 ISSCT Agronomy Workshop was held from 24 to 28 May 2009 at the Plaza Convention Centre in Uberlandia, Brazil. The workshop was very well organised with three institutions collaborating closely (the Federal University of Uberlandia, the Society of Sugar Cane Technologists of Brazil and APTA) to make the attendance worthwhile and interesting to the participants. However, with the world economy in recession, the response by sugarcane technologists to the workshop was understandably below expectation as, of the 70 participants, only 22 of them were from overseas from 13 different countries.

The workshop nevertheless was an excellent opportunity for the participants from overseas to acquire an overview of the sugar industry in Brazil, in particular the cultural practices and the status of research and development in the country. The constraints to the sugar industry worldwide

at the beginning of this 21st century are wide ranging and, in agronomy, they tend to be the same in all countries. Those constraints to the viability and sustainability of the sugarcane production systems cannot be resolved by research and development in just one specific discipline in agronomy. Instead an integrated approach is warranted and accordingly the theme of the workshop *Sugar production: Integration among sugar, alcohol, residue cycling and sustainability* was chosen to cover the spectrum of interests in agronomy.

Following the opening of the workshop by the Mayor of the City of Uberlandia and a very enlightening keynote address on '*Perspective for the sugar cane production in Brazil and in the world*' by Dr Roberto Rodrigues, a former Minister of Agriculture of Brazil, the scene for discussion and interaction among the technologists was set by 33 oral presentations (and 16 posters) spread under the five following specific themes.

- New technologies for sustainable sugarcane production.
- Ratoon yield decline and its management.
- Modelling sugarcane growth and production.
- Soil and plant residue management.
- Challenge of environmental pressure and strategy for the sugarcane grower.

The discussion after each presentation was positive and lively, demonstrating the interest and willingness of the participants to share and exchange their know-how. A report on the presentations and discussions is given in the sections below.

Report and discussion

Optimum sugar cane productivity

One factor that is often overlooked and yet is the basis of a successful sugarcane crop is the necessity for high quality seed cane, particularly free from diseases. Attention to the central role which high quality seed cane plays in reducing costs and bringing out the real productive potential of sugarcane varieties grown was demonstrated in Tucuman, Argentina. Here one of the constraints to sugarcane production was the lack of nurseries guaranteeing high quality seed cane availability and purity, with the result that commercial plantations have widespread high RSD incidence levels (>50%) which may cause production losses of 50%. It also emerged from the workshop that once high quality seed is planted, an integrated approach to the management of the sugarcane crop must be adopted to optimise productivity. In this context, work in Thailand showed that while dual-row planting raised cane yields by 26–31% in plant cane and by 12–24% in first ratoon, dual-row planting with green manuring increased cane yields by 47–48%, while irrigation with recommended fertiliser and dual-row planting caused cane yields to rise by as much as 64–72% without the quality of the cane juice being affected.

It was also evident that to optimise productivity, the most appropriate technology or agronomic management system must be chosen. Thus, though many different irrigation systems are available and can be adopted, work done in Brazil demonstrates that drip irrigation conserves water and energy, thereby further increasing the profitability of the sugarcane production system particularly when varieties showing a better yield potential under the drip irrigation system are grown. The results obtained in Brazil showed a rise in sugarcane production of some 30 tonnes cane per hectare under drip irrigation, with different responses being obtained among the varieties tested.

Further avenues to optimise the profitability and sustainability of the sugarcane production systems that were presented at the workshop were:

- *Use of a foliar biofertiliser consisting of mesophilic, cellulolytic, ammonifying and nitrifying fungi and yeasts and containing low quantities of NPKCa and micronutrients*. Studies in Argentina showed that 10 L/ha of this foliar biofertiliser was an effective substitute for half the dose of N traditionally supplied by synthetic sources, that is 120 kg N/ha as urea instead of 240 kg/ha.

- *Adoption of leguminous green manure not only to provide nitrogen to the crop but also to improve the fertility of the soil by gradually increasing the organic matter content in the soil and to hinder the development of the weed population*. Work in Brazil showed that sunhemp decreased the incidence of light and thermal amplitude on the ground, thereby hindering the germination of weeds. In field trials, while the control without green manure gave cane yields of 135.5 t/ha, treatments with pigeon pea and *Crotalaria juncea* produced 158.8 and 157.0 t cane/ha, respectively. Studies of different rotation systems with leguminous crops in Brazil further showed that the best rotation system for sugarcane in that country was a two-year soybean cultivation as opposed to fallow, one-year soybean cultivation and one or two years with *Crotalaria*.
- *Adoption of a weed management strategy based on the critical period of competition between weeds and sugarcane*. Weed control in sugarcane in Mauritius has traditionally been achieved by two or even three herbicide applications per cropping season and is often complemented by manual weeding. With the adoption of a new strategy based on the initial period of weed control which started at least 6 weeks after planting or harvest and which ended 14–20 weeks later, there was a saving of at least one herbicide application per season. Further savings in herbicide costs were achieved by adoption of mechanical weeding during the first 12–16 weeks after planting and in ratoon by promoting the adoption of green-cane trash blanketing.
- *Controlling prevalence of pests*. Harvest age has been presented as being critical to production of sugarcane in South Africa, a 12, 18 or 24 month cycle being practised depending on the environment. Data were presented to show that lower yields were obtained for the 18-month cane as a result of *Eldana* damage associated with aging of the sugarcane along the coast. High yields with aging cane can only be achieved by planting appropriate varieties that have good *Eldana* resistance. In the control of pests, the merit of silicon to induce sugarcane resistance to insects such as spittlebugs was demonstrated in Brazil.

Management of trash residues

It was clear at the workshop that soil organic matter conservation and build up in the soil are most critical for a sustainable sugarcane production. Data presented from Argentina showed that a trash-blanket treatment led to a significantly higher crop yield (83.5 tonnes cane/ha) as compared with a treatment without residue retention (53.7 tonnes/ha). It was, however, also evident from the presentations and discussion at the workshop that one system of trash-residue management could not fit all situations. The management of the residues from green-cane harvesting still needs to be researched and tested under specific local conditions to avoid drawbacks such as prevalence of pests like the spittlebug, or slower shoot appearance and lower tillering rate as a result of lower temperature under the trash blanket causing ultimately a reduced sugarcane yield as was observed for instance in Brazil. It was reported that a 100% trash cover of the soil gave for instance 83 tonnes cane/ha as opposed to 91 tonnes/ha and 96 tonnes/ha in trash management systems covering respectively, 66% and 33% of the soil surface. Under the temperate climatic conditions of Louisiana, burning the trash as soon as possible after harvest was even shown to give consistently better yields than when the mulch was left on the field after harvest or mechanically removed by a hay bailer.

New technologies

The workshop was an opportunity to present progress or refinements in new technologies that can be applied in sugarcane agronomic management systems. Biomass estimates inferred from remote sensing techniques were shown to be well correlated with gross cane yields obtained from field measurements in Louisiana. The yield variations within field were sufficiently large to justify a precision agriculture approach in the management of the crop. In this context, the suitability of mapping soil pH and electrical conductivity in a 25–ha fallow sugarcane field to assist producers in developing lime variable rate application in sugarcane was demonstrated. Progress in modelling sugarcane growth has been achieved with an up-to-date Canegro model modularised and

incorporated into the DSSAT4.5. Though room for improvement exists, the model was shown to perform fairly well when simulations were compared with experimental data.

In the investigation of the sugarcane root system, particularly root length density which, though a key factor for sugarcane water and nutrient uptake, is difficult to measure, a technique was presented based on root intersection counting with a 0.5 m x 0.5 m mesh grid on a soil profile and modelling the root length density from the root intersection counting. This new method is 10-fold, less time consuming than the core sampling method and has the merit of not needing the export of soil samples. Using the technique developed, studies in Brazil have provided evidence that sugarcane root development in ratoon is not affected by the changes in soil management practices, namely from conventional tillage (soil cultivation and disking twice at planting) to minimum tillage (soil cultivation with one disking at planting) and to no tillage (only disking at planting).

Initiatives required

The workshop in Brazil moreover has the merit of drawing attention to the need for broadening the research base in the agronomy of sugarcane. Current research on sugarcane is focused on contemporary cultivars which are designed to have low to moderate fibre levels and high sucrose and fermentables for sugar or ethanol production. A shift in paradigm is now occurring with the higher demand for high fibre cultivars for electricity cogeneration or for conversion of cellulose and hemicellulose to ethanol and syngas. The impact which this shift in paradigm has on biomass partitioning in sugarcane will need to be studied from all angles in agronomy. Preliminary results from Australia showed that, though cultivars did not generally result in significant difference in total biomass production or in the yield of the vegetative components, significant differences, however, occurred among the cultivars in the partitioning of the dry matter to fibre and soluble sugar equivalents. Research in such areas as fertilisation, cultural operations and irrigation needs to be pursued to optimise the partitioning of the biomass depending on market economies which will include consideration of price for products, processing costs and conversion efficiency. Work done in Japan has in this context indicated that high biomass cultivars may require more nitrogen and potassium than conventional sugarcane varieties.

Progress in research and development of sugarcane initiatives focussed only on the economic and environmental pillars of sustainability would not suffice to achieve the objective of higher productivity. Indeed it emerged at the workshop that less tangible factors such as trust, communication and coordination between growers and contractors or other stakeholders are equally important and should not be ignored. These factors have a direct impact on agronomic practices at field level as demonstrated in a study in South Africa where, in spite of climate, soils and terrain being well suited to sugarcane production, the reality over the past 10 years or more had been a persistent decline in yields and land abandonment. The study confirmed the occurrence of numerous improper practices at field level such as lengthy harvest to crush delays, poorly controlled burning, improper weed and fertiliser management, the root causes of which could all be traced back to social and organisational constraints at the local community levels rather than to lack of knowledge.

Conclusions

The workshop has been a success due to a large extent to the effort made by the local organising team led by Professor Gaspar Korndorfer. Research-wise, the workshop provided the opportunity to gauge the progress accomplished in sugarcane agronomy during the three years since the preceding workshop was held in Thailand in 2006. If there is no doubt that profitable and sustainable sugarcane production lies most importantly in soil organic matter conservation, particularly through green-cane harvesting, it is also clear that more effective techniques for incorporating the residues into the soil than current available methods remain a research challenge in many sugarcane growing areas of the world. The incidence of some negative results on productivity arising from trash blanketing has also served to emphasise that one solution could not fit all situations and each research finding requires testing under the specific local conditions prevailing in each country or state.

The workshop has also reinforced the awareness that the sugar industry in the world has common goals in agronomy, namely the search for alternatives to mineral fertilisers through research on green manuring and on biofertilisers, more efficient means of pest control, a more effective irrigation system and weed management so as to minimise production costs. However, the research and development in agronomy will not attain the desired goal of higher productivity if impeding factors such as trust and coordination among the stakeholders are not simultaneously addressed.

PRODUCTION SUCRIÈRE: INTÉGRATION ENTRE SUCRE, ALCOOL, RECYCLAGE DES RÉSIDUS ET DURABILITÉ – UN RAPPORT SUR L'ATELIER 2009 D'AGRONOMIE

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Résumé

L'ATELIER DE travail 2009 en agronomie a eu lieu du 24 au 28 mai 2009 à Uberlândia, Brésil. Il a réuni quelque 70 participants dont 22 venaient de 13 pays différents d'outre-mer. L'atelier de travail a été un succès avec 33 présentations orales (et 16 posters), répartis sous cinq thèmes spécifiques: les nouvelles technologies pour la production durable de canne à sucre, la baisse de rendement en repousses et sa gestion, la modélisation de la croissance de la canne à sucre et de la production, la gestion des résidus du sol et de la plante, et le défi de la pression environnementale et de la stratégie pour le producteur de canne à sucre. L'atelier de travail a procuré l'occasion d'avoir un aperçu de l'industrie sucrière brésilienne, en particulier les pratiques culturales adoptées et l'état de la recherche et du développement dans ce pays. L'atelier de travail a également été l'occasion de rappeler aux technologues que l'optimisation de la production cannière requiert avant tout des semences de bonne qualité pour l'établissement des plantations et l'adoption d'une approche intégrée dans la gestion de la culture. Cette approche intégrée repose sur l'adoption de la technologie la plus adaptée en irrigation, fertilisation, contrôle des mauvaises herbes et protection de la culture. Bien qu'il soit admis que la viabilité du système de production de canne à sucre se trouve dans la conservation de la matière organique du sol, en particulier avec la récolte de la canne en vert, la gestion des résidus afin d'éviter la perte de productivité doit encore être étudiée. Il n'y aura pas d'application universelle du système de gestion des résidus, chaque système devant être testé selon les conditions locales spécifiques. L'atelier de travail a conscientisé les participants sur le fait qu'avec l'augmentation de la demande pour des variétés à forte teneur en fibre pour la cogénération, et la production de l'éthanol, le paradigme dans la recherche et le développement de la canne à sucre est appelé à se déplacer vers l'optimisation de la partition de la biomasse en faveur de la fibre. L'atelier de travail a également créé une prise de conscience que la recherche et les initiatives de développement n'atteindront pas les objectifs fixés de l'amélioration de la productivité si les contraintes sociales et organisationnelles ayant un impact négatif sur les pratiques agronomiques au niveau des champs ne sont pas résolues.

PRODUCCIÓN DE AZÚCAR: INTEGRACIÓN ENTRE AZÚCAR, ALCOHOL, UTILIZACIÓN DE RESIDUOS Y LA SUSTENTABILIDAD – INFORME SOBRE EL TALLER DE AGRONOMÍA 2009

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PALABRAS CLAVE: Productividad, Manejo de Trash, Abono Verde, Irrigación, Fertilización, Control de Malezas.

Resumen

EL TALLER de Agronomía 2009 se llevó a cabo del 24 al 28 de mayo de 2009 en Uberlandia, Brasil. Asistieron a él 70 participantes, de los cuales 22 habían cruzado el océano, arribando desde 13 países diferentes. El taller fue un éxito, con 33 presentaciones orales (y 16 pósteres) que versaron en los siguientes cinco temas específicos: nuevas tecnologías para una producción sustentable de azúcar, la disminución del rendimiento de la caña soca y su manejo, el uso de modelos para el crecimiento de la caña y su producción, el manejo del suelo y residuos de la planta y el desafío de la presión ambientalista y estrategias para el productor cañero. El taller también constituyó una oportunidad para reflexionar acerca de la industria azucarera en Brasil, en particular en lo que concierne a las prácticas culturales adoptadas allí y el estatus de la investigación que se lleva a cabo en el país y su desarrollo. El taller ha servido para recordarles a los tecnólogos que, para optimizar la producción de caña de azúcar, se requiere la utilización de semilla de alta calidad para establecer la plantación y la adopción de un enfoque integral del manejo del cultivo. Este enfoque integral para optimizar y aumentar la productividad involucra la adopción de las tecnologías más adecuadas para la irrigación, fertilización, control de malezas y protección del cultivo. Aunque se acepta la idea de que un sistema de producción de caña de azúcar sustentable se basa en la conservación de la materia orgánica del suelo, particularmente mediante la cosecha de caña en verde, se necesita aún investigar sobre manejo de residuos para evitar pérdidas en la productividad. No existe ni existirá un sistema de manejo de residuos universalmente aplicable, y cada sistema necesitará ser evaluado en las condiciones locales predominantes. Con la demanda creciente de cultivares con mayor contenido en fibra para la cogeneración y síntesis de bioetanol, la investigación y desarrollo de la agronomía de la caña de azúcar estará cada vez más focalizada en optimizar la partición de la biomasa a favor de la obtención de fibra. El taller también ha logrado que se tome conciencia de que si no se trabaja sobre las limitaciones sociales y organizativas que impactan negativamente en las prácticas agronómicas a nivel del campo, las iniciativas en investigación y desarrollo para aumentar la productividad no lograrán su cometido.