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AGRICULTURAL ENGINEERING AGRONOMY • EXTENSION

3rd Agricultural engineering, agronomy and extension workshop

«Farming for the future: improving productivity and ecological resilience in sugarcane production systems»

23 to 28 September 2018

Hotel Le Récif, Saint-Gilles, La Réunion



ARTAS Association Réunionnaise de Technologie Agricole et Sucrière

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General Program

Date	Subject	Place
Sunday 23rd	16:00 - 18:00: Registration 18:00: Welcome cocktail	Hotel Le Récif Saint-Gilles
Monday 24th	7:30 - 8:20: Registration Workshop	Hotel Le Récif Saint-Gilles
Tuesday 25th	Field Trip	North of Reunion Island
Wednesday 26th	Workshop	Hotel Le Récif Saint-Gilles
Thursday 27th	Field Trip Gala Dinner	South of Reunion Island Hotel Le Récif Saint-Gilles
Friday 28th	Workshop Afternoon: Departure	Hotel Le Récif Saint-Gilles

Monday 24 Sep 2018

Session	Chair	Time	Presenter	Presentation
Welcome and introduction	Daniel Marion	**08:20 - 08:40**	Daniel Marion	Introduction
		08:40 - 09:00	Prof Robert Gilbert	Opening address
		09:00 - 09:20	Daniel Marion	Visual presentation
		09:20 - 09:40	Bernard Schroeder	Report back
		09:40 - 09:50	Panel	Discussion
		09:50 - 10:05	**Trade exhibition / agricultural equipment**	
		10:05 - 10:30	**MORNING TEA**	
Continuum: need to adoption	Prof. Bernard Schroeder	**10:30 - 10:50**	Felice Driver	Oral presentation 1
		10:50 - 11:10	Daniel Marion	Oral presentation 2
		11:10 - 11:30	Matthew vanWeelden	Oral presentation 3
		11:30 - 11:40	Panel	Discussion
Session 1 **Farming systems**	Dr. Sanesh Ramburan	**11:40 - 12:00**	Neil Lecler	Oral presentation 4
		12:00 - 12:25	Osamu Yatabe	Poster 1
			Dai Sugimoto	Poster 2
			Christophe Poser	Poster 3
			Christophe Poser	Poster 4
			Hardev Sandhu	Poster 5
		12:25 - 12:45	**POSTER VIEWING 1**	
		12:45 - 14:15	**LUNCH**	
Session 2 **Numerical agriculture and harvesting**	Dr. Troy Jensen	**14:15 - 14:35**	Pierre Todoroff	Oral presentation 5
		14:35 - 15:10	César Arévalo	Poster 6
			Sandrine Auzoux	Poster 7
			Mathias Christina	Poster 8
			Alasdair Harris	Poster 9
			Alizé Mansuy	Poster 10
			Kazuhiro Okuzawa	Poster 11
			Troy Jensen	Poster 12
		15:10 - 15:40	**AFTERNOON TEA + POSTER VIEWING 2**	
Group activity		**15:40 - 17:00**	**WORKING SESSIONS n° 1 and 2**	
Dr. Neil Lecler		**17:00 - 17:10**	**WRAP-UP FOR THE DAY**	
Dr. Pierre Todoroff		**17:10 - 17:20**		

Monday 24 Sep 2018

Continuum: need to adoption

Chairman: Prof. Bernard Schroeder

Oral presentation		
Felice Driver	1	Research, development and adoption in the Australian sugar industry - maximising stakeholder value and impact
Daniel Marion	2	A research, development and training network for the sugarcane sector in Reunion
Matthew vanWeelden	3	Extension education programs for sugarcane best management practices in Florida's Everglades Agricultural Area

Research, development and adoption in the Australian sugar industry - maximising stakeholder value and impact

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Abstract

Sugar Research Australia Ltd (SRA) is one of 15 Research and Development Corporations (RDCs) that operate on behalf of rural primary producers in Australia. The RDCs have a role to invest mandatory levy funds (those paid by farmers and millers in the case of sugar) along with government co-contributions to serve and further a particular industry's needs and interests. This joint funding forms the basis of a sustainable investment platform for the industry. SRA has a five-year strategic plan developed in consultation with our sugar industry investors and stakeholders to guide and ensure that it invests in research, development and adoption (RD&A) required by industry to deliver value and impact. Our purpose is to help growers and millers to maximise profit by improving productivity and value adding while enhancing the industry's sustainability and securing market access for its products. SRA has a crucial role in communication and facilitating adoption of new technologies and practices. The presentation discusses the driving forces on the sugar industry to rationalise and prioritise how levy funds are invested, and the strategies and opportunities available for further leverage of industry resources against other grant schemes and partnerships. This ensures that each stakeholder dollar works hard to provide high-impact returns to the Australian sugar industry.

The SRA Board and Research Funding Panel identified the need for a program approach across at least some of SRA's RD&A portfolio. This approach is more likely to deliver better medium to long-term industry outcomes, especially in complex areas, than *ad hoc* support of uncoordinated research projects. Three case studies are highlighted that illustrate the development of program structures through a participatory planning approach and facilitated consultations with industry, researchers, stakeholders and government policy staff. This has resulted in mandates for prioritised investment in areas of nutrient management, industry harvesting best practice (HBP) and soil health.

The Australian sugar industry operates in challenging and sensitive environments with proximity to the Great Barrier Reef. It is under pressure to manage mobile nutrients [such as nitrogen (N)] efficiently, benchmark crop fertiliser-use and quantify improvements in fertiliser use efficiency.The industry is well served by a decision support system like the SIX EASY STEPS (6ES) program. It provides a framework for incorporating information and technology developments that address identified knowledge gaps. Continuous updating of the 6ES interpretive guidelines provides industry with a vehicle for implementing improved nutrient use efficiency. The associated 6ES extension framework offers the potential for rapid dissemination of new information and approaches to industry. In particular, SRA works cooperatively to facilitate better coordination and communication of industry and government research, investment and extension activities. The aim is to maintain or improve crop production and grower profitability while realising water quality targets and positive environmental outcomes.

Harvest losses through mechanised harvesting in Australia are conservatively estimated to cost the industry about $150 M each year. Three workshops were held in late 2015 for millers, growers, harvester operators and researchers to identify where there are

opportunities for improvement and to help prioritise ideas for RD&A investment. Following industry consultation, a program to address harvest losses was developed. It combines technology improvements with demonstration of HBP to individual harvesting groups. Research organisation and industry cash, and in-kind contributions have leveraged additional funding from the Australian government via the Rural R&D for Profit program.

Since the 1970's, sugarcane production has plateaued, coinciding with fully mechanised harvesting. Cumulative losses (plant cane – second ratoon) are estimated at 15-45% across the sugarcane production areas. Improving soil condition and capability is a multi-faceted problem and cannot be achieved without changes in the farming system. The Soil Health Program (SHP) strategy reflects an industry view of adoption and practice-change that is backed by R&D within an investment timeframe of at least 10 years. The program plans to build pathways for farmers to address whole-farm management problems that affect soil condition, and for R&D projects to develop innovations for subsequent adoption within best management practices.

Keywords: sugar industry, stakeholder, levy funds, strategic planning, R&D, adoption, program structures

A research, development and training network for the sugarcane sector in Reunion

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Abstract

Many innovations have been proposed by research institutes and agricultural development bodies in the French overseas territories [*Départements* Outre-Mer (Dom)] – **Reunion** and Mayotte in the Indian Ocean, Guadeloupe and Martinique in the Caribbean, and Guyana in South America. The lack of transfer of these innovations remains a weak point of agricultural development in these territories. In particular, this has applied to the sugarcane sector in **Reunion,** comprising 3,000 cane growers operating on 24,000 hectares of land. To counter these difficulties, a network for innovation and agricultural technology transfer *(Réseau d'Innovation et de Transfert Agricole*, RITA) has been established to bring together growers and other participants - from research to training - according to their specialised areas of expertise.

In order to meet the growers' requirements, a survey was conducted to identify their specific needs. The results revealed a strong demand for agronomic guidance in terms of fertiliser practices, weed control, choice of varieties, irrigation management, etc. Small-scale trials were subsequently established to identify technical improvements within particular study areas and encourage growers to take advantage of these innovations.

The transfer mechanism of trial results is based on a dynamic network of participants who are acquainted with the day-to-day realities of farming, thereby facilitating the adoption of the innovations. Growers, in collaboration with an assigned extension technician, can implement a changed practice (based on research results) in a particular block of cane, by comparing it with their usual techniques. This process provides growers, extension technician, institutional agronomists and researchers with fresh opportunities to interact, share their expertise and identify further needs. The demonstration trials also enable the extension technicians to meet and improve their technical recommendations. They also allow researchers to more fully understand real-life situations in the field, which sometimes, are quite different from those encountered during their experiences in research trials.

This network, that allows solutions to be developed through the breaking down of barriers, facilitates the exchange of information and involvement of all participants within the agricultural sectors of the five overseas territories within Dom. It also allows interaction of several agricultural sectors within the same network. Each network, based on a common organisation managed by local governance, a steering committee, and a coordinator, adapts its operations to the specificities of its territory or, where necessary, of its sector. A national coordinating unit facilitates exchange of information between networks, particularly via the implementation of working groups on themes of mutual interest on an inter-Dom and/or inter-sector basis. For example, the sugarcane sector takes part in working groups on fertiliser management, cover crops, etc., the running of an information system (http://coatis.rita-dom.fr), and the organisation of inter-Dom technical days.

Keywords: sugarcane, Reunion Island, extension, and inter-Dom

Extension education programs for sugarcane best management practices in Florida's Everglades Agricultural Area

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Abstract

The Everglades Agricultural Area (EAA) is a 700,000 acre drained basin located north of the Florida Everglades. Phosphorus (P) run-off originating from residential and agricultural areas has resulted in ecological imbalances within the Everglades, and in 1994, the Everglades Forever Act was passed to implement regulations to improve the quality of water entering the Everglades. Approximately 400,000 acres of sugarcane grown in the EAA, along with other rotational crops, are subject to best management practices (BMPs) to reduce on-farm P discharge levels. The goal of this program aims to reduce overall P loads by 25%. Here we present results from a series of on-farm and lecture-based BMP extension workshops aimed at providing growers with the latest recommendations from the University of Florida.

Two BMP extension workshops were organized in 2017. To cater to multiple learning styles, the first workshop adopted on-farm demonstrations to provide farmers and agricultural personnel the tools required to abide by the mandatory BMPs in the EAA, while the second workshop included indoor, lecture-based modules. Topics from both workshops included sugarcane BMPs, water retention, management of floating aquatic vegetation, nutrient management, sediment control, and soil testing. Evaluation forms were distributed to participants at the conclusion of the program to determine knowledge gained from the discussed topics in addition to growers' willingness to adopt or modify their current BMPs.

A total of 114 growers and agriculture personnel from the local industry attended the extension workshops. Results from both extension workshops indicated that 55% of attendees agreed that they would adopt or modify at least one of their BMP strategies in sugarcane, and that 98% of attendees have a better knowledge of sediment management on sugarcane farms. In addition, attendees noted that the on-farm training provided a more effective hands-on learning experience when compared to the lecture-based modules. Attendees noted on their returned valuations that these training sessions should be conducted more than twice a year and should be bilingual (English and Spanish).

Extension workshops were successful in providing sugarcane BMP recommendations to growers in the EAA, in addition to establishing behaviour changes associated with BMP implementation. Digital learning modules will be implemented to expand the strategy to audiences outside of the EAA.

Keywords: BMP, phosphorus, Florida, extension

Monday 24 Sep 2018

Session 1: Farming systems

Chairman: Dr. Sanesh Ramburan

Oral presentation		
Neil Lecler	4	An autumn re-plant system for irrigated sugarcane in southern Africa
Posters		
Osamu Yatabe	1	Developing high-yielding cultivation technology for sugarcane ratoon crops in north-east Thailand - effects of deep planting on plant cane
Dai Sugimoto	2	Developing high-yielding cultivation technology for sugarcane ratoon crops by mechanical deep planting in north-east Thailand
Christophe Poser	3	Sugarcane detrashing and field traffic control as factors of crop longevity on Reunion Island?
Christophe Poser	4	Germinated single-bud setts in pots: a way to improve ecological resilience at planting
Hardev Sandhu	5	Post-harvest trash removal effects on soil temperature and ratoon growth in green harvested sugarcane

An autumn re-plant system for irrigated sugarcane in southern Africa

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Abstract

Traditionally most of the irrigated sugarcane in southern Africa is replanted in spring. A reason has been to minimise the potential growth losses associated with the three-month fallow period by having the fallow period in winter. A three-month fallow period is recommended as a control measure for ratoon stunting disease. For spring re-plants, the plant crop is typically grown for approximately 14 months and therefore starts its life towards the end of the milling season, in October or November. To maintain a rateable supply of cane to a mill, the harvest month for most fields needs to be moved to earlier in the season in subsequent ratoons. Thus, the aim of harvesting ratoon crops at 12 months of age is compromised and the average harvest age over a full crop cycle is typically closer to 11.5 months. Here we present a motivation for an alternative re-plant strategy where sugarcane is planted in autumn so that the plant crop is harvested at the beginning of the milling season. Among other things this facilitates cutting all ratoon crops at an age older than 12 months when the crop is relatively mature with a higher sucrose content, whilst still maintaining a rateable supply of cane to a mill.

The investigation encompassed analysis and/or development and synthesis of:

- Data relating to cane age and sucrose content, and yield decline with ratoons;
- Recommendations to promote soil health and reduce pest and disease pressures;
- Technologies and systems to facilitate more cost-effective re-planting; and
- Results from a project where a pilot system was implemented on 500 ha in Zimbabwe.

Results showed that an autumn re-planting system would have substantial advantages over the traditional spring re-planting systems. The development and simulation models were useful for scenario assessments, including implications for transitioning a farm or estate to the new autumn re-planting system. Results from the Zimbabwe pilot project confirmed the very favourable theoretical findings showing substantial increases in yields and profitability, and much improved water use efficiency.

Challenges to implementation include:

- A lag in income associated with moving to a system where cane is re-planted in autumn rather than spring;
- Understanding and implementing the fundamental changes that need to be made to the farming system to facilitate re-planting in autumn when there are usually wetter field conditions.

The opportunity to incorporate cash-crops as part of an autumn re-plant strategy can help reduce the income lag.

Keywords: Farming system, economics, machinery, break crops, cane age

Developing high-yielding cultivation technology for sugarcane ratoon crops in northeast Thailand - effects of deep planting on plant cane

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Abstract

Bud germination after planting is variable in northeast Thailand where sugarcane is planted in the early dry season. The high volume of missing plants and lighter one-stalk weights in ratoon crops also affect the productivity of ratoon crops. It is surmised that soil moisture markedly affects both germination and growth of stalks. As a result, we evaluated changes in the effects of different depths of planting on germination rate and yield-related characteristics. This included assessing missing plants and one-stalk weights by planting sugarcane at different depth where moisture could have been present even in the dry season.

Four 'depth of planting' treatments [10 cm, 20 cm (based on regional practices), 30 cm, and 40 cm] were investigated in a randomized block trial that contained three replicates. Each plot was 5 m long x 4-rows wide (with 1.5 m inter-row spacing). The trial was established in mid-November about one month into the dry season. This was done by planting 20 three-budded setts/m in dual rows using sugarcane cultivar KK3. Approximately 10 cm of soil covered the planted setts in all sections. The amount of applied fertilizer was based on regional custom.

Percentage germination six week after planting was 11.3%, 26.3%, 36.7% and 45.2% in the 10, 20, 30 and 40 cm depth treatments respectively. Fewer missing plants occurred in the deeper planting grooves. One-stalk weights and cane yield at the time of harvest were 1.78 kg and 84.4 t/ha, 1.93 kg and 133.9 t/ha, 2.05 kg and 157.7 t/ha, and 2.12 kg and 149.5 t/ha in the 10, 20, 30 and 40 cm depth treatments respectively. Coefficients of variation (%) of the number of millable stalks, one-stalk weight and cane yield were lower in 30 cm and 40 cm depth treatments (33.1, 9.55 and 38.47; and 21.84, 10.83 and 29.12 respectively) than in 10 cm and 20 cm depth treatments (57.37, 22.49 and 72.44; and 39.06, 15.46 and 48.49 respectively).

The above-mentioned results indicate that deeper planting may lead to fewer missing plants and to increased numbers of millable stalks, one-stalk weights and cane yield. We suggest that this may, in turn, result in improved ratoon crops. This work will be continued.

Keywords: sugarcane, ratoon crop, deep planting, missing plants, one-stalk weight, cane yield

Developing high-yielding cultivation technology for sugarcane ratoon crops by mechanical deep planting in northeast Thailand - effect of mechanical deep planting on planted sugarcane

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Abstract

A sugarcane chopper-type planter that enables deep planting has been developed to contribute to labour-saving in cultivation of high-yielding sugarcane ratoons in northeast Thailand. In this region, severe dry seasons cause substantial losses in both plant and ratoon crops, low stalk weights in ratoon cane and low yields. We intended to promote germination and initial growth by mechanically planting billets in deep furrows in soil with relatively high moisture content. To minimize additional costs, the development of this system was based on a precondition that local tractors could be used for this purpose.

While planting depth for existing planters was about 20 cm, the modified planters allowed planting to about 30 cm. In addition, a subsoiler was attached to the planter to enable drainage under heavy rainfall conditions. Billets were planted in November 2015 to depths of 20 cm (current practice) and 30 cm (deep-planted cane) in experimental plots in Udon Thani in northeast Thailand, where the local soil is characteristically sandy. The aim was to evaluate the practical use of mechanized deep-planting and determine major points for improvement. Sugarcane cultivar KK3 was used and the row-spacing was 140 cm (according to usual local practice). The soil cover was about 7 cm and fertilizer management, inter-row tillage and ridging operations were undertaken according to local practices. Plot size was about 130 m long × 6 rows wide. The trial include three replicates.

The plant cane was harvested in January 2017. Many missing plants occurred in the ‘current practice’ plots but there were fewer gaps in the ‘deep planted’ plots. Tiller numbers were about the same in both treatments areas. However, as the billets were planted deeper than the plough layer in the ‘deep-planted’ areas, poor tillering in some places could presumably be attributable to insufficient fertilizer. Mean stalk length three months after planting was higher in the ‘deep-planted’ plots (23.3 cm) compared with values associated with ‘current practice’ plots (23.1 cm). Initial growth was slightly better in the ‘deep-planted’ plots compared with that of the ‘current practice’. The cane yield was also higher in the ‘deep-planted’ plots (875 kg/a) than that of the ‘current practice’ plots (703 kg/a).

To eliminate variability of tillers in the ‘deep-planted’ plots, basal fertiliser dressing 50% greater than the usual practice was applied to the cane in October 2017 (the end of the rainy season and medium soil moisture) and November 2017 (dry season and less soil moisture). Observation of the test plots at the end of January 2018 confirmed quicker germination and less variable tiller numbers in the ‘deep planted’ plots compared with those of the ‘current practice’. Substantial leaf rolling caused by dryness occurred in the ‘current practice’ plots, with steady growth in the ‘deep-planted’ cane.

Keywords: sugarcane, ratoon crop, deep-planting, mechanization

Sugarcane detrashing and field traffic control as factors of crops longevity on Reunion Island?

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Abstract

Sugarcane cultivation is a major environmental concern on Reunion Island. By the 2010s, the ± 25,000 ha of the sugarcane belt covered about 57% of the agricultural land. Of this, 75% was cut by hand. Sugarcane detrashing has been recognized for almost 20 years as an agri-environment practice (in different forms and extents). The Ministry of Agriculture currently provides subsidies to farmers who voluntarily subscribe to agri-environment practices - 675 €/ha in the case of the sugarcane detrashing, committed for five years on a maximum of 10 ha. In 2016, 25% of cane growers, representing 15% of the total sugarcane area, were involved in detrashing.

Sugarcane detrashing involves manual removal of the dry leaves from the stalks during the last months before manual cutting (generally February to July). It rejuvenates the soil mulch and aims to enhance soil conservation, moisture and fertility, and reduce herbicide usage. Commitment to detrashing also includes retention of all trash in the field at harvest and covering areas of bare soil subsequent to mechanical cane loading. Sugarcane detrashing is not a research outcome, but rather a practice often undertaken by growers without much input and/or knowledge from researchers. In 2013, there was a request by an agricultural education partner for detrashing to be included in a management of cane borer trial. It was considered suitable for their learners as it assisted in reducing penetration by stalk borers.

A farm survey was undertaken in 2014 as part of a student internship. This included interviewing 21 farmers known to extension officers as 'good detrashers'. The intent was to increase knowledge of the growers themselves, their practices and their perceptions about sugarcane detrashing. It appeared that these detrashers were predominantly small-scale farmers mainly involved in growing sugarcane. Their agricultural and environmental performances were significantly higher than the average grower in terms of cane yield and sugar content, herbicide dependence, and longevity of their crops. A 'field cleaning' effect was consequently recognized as residual weeds are removed during the detrashing activities. The growers indicated that insect populations and rat infestations were reduced. There was an interactive effect between sugarcane cultivars and detrashing particularly in terms of moisture conditions and the occurrence of logging. Apart from the danger of fire ants and wasps, labour requirements remain the main constraint for detrashers.

In 2016, a second student internship investigating soil carbon (C) resulted in additional information on factors affecting sugarcane longevity. Interviews with eight farmers, known for the longevity of their crops, revealed that field traffic control during harvest was one of the most important factors, even with hand-cutting through careful loading and tracking operations. Higher crop performance occurred over a 30-year period with yields in excess of 100 t/ha and high sucrose contents. In addition to appropriate choices of cultivars, longevity of sugarcane crops on Reunion Island results from a range of good cultural practices that include and/or field traffic control.

Keywords: sugarcane, Reunion Island, detrashing, weed control, herbicide saving, labour constraint, field traffic control, crop longevity.

Germinated single-bud setts in pots: a way to improve ecological resilience at planting

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Abstract

In order to increase the area of sugarcane production, planting techniques should ensure uniform crop emergence and control of weeds at reasonable cost. Experiments using single-bud setts have been conducted in several countries (Brazil, India, Indonesia, and Egypt). In this poster, we present the advantages of planting germinated single-bud setts grown in pots into a cover crop with the aim of reducing soil tillage and herbicide usage in an agro-ecological approach to sugarcane production.

Two trials were carried out to assess the effectiveness of germinated single-bud setts compared with traditional planting of three-bud setts. This included i) the quantity of planting material, yield and components thereof, and ii) the use of herbicide. In the first trial, the weights and number of tillers per plant were measured at 11 months after planting. In the second trial, germinated single-bud setts were planted into plant cover originating from a succession of a planted mixture of *Crotaleria juncea* and *Mucuna,* and *Avena sativa*. Tillering, stalk elongation and yields (plant and ratoon) were compared with those of traditionally planted cane in single rows. Time and herbicide inputs were quantified.

In the first trial, both yields and number of nodes per stalk were similar for the germinated single-bud setts and the traditionally planted cane, but the number of stalks was significantly higher (8%) for the germinated single-bud setts. The average multiplication rate of the single-bud setts was 1:99 at 11 months. In the second trial, the number of tillers was again 8 % higher for the single-bud setts. There was no significant differences in stalk elongation and yields. In ratoon cane, no significant differences were observed. From an economic point of view, a saving of more than 80% of buds was achieved at planting. However, the increased labor requirement generated additional costs. Planting germinated single-bud setts into mulch resulted in reduced herbicide applications and erosion risks.

Our study highlighted planting of germinated single-bud setts (in pots) into mulch as a reliable and affordable technique. In terms of the planting operation and yields, it is comparable with conventional planting techniques and can reduce soil tillage and the use of herbicides. Theoretically this technique reduces the risk of erosion while favoring water retention and increased functional biodiversity. It gives the advantage of complete and homogeneous emergence, as well as the possibility of bringing complementary nutrients in the pot near to the roots. Nevertheless, for Reunion Island conditions, progress still needs to be made in terms of acclimatization and mechanical transplantation of young plants.

Keywords: plantation, single-bud sett, mulch, ecological resilience, sugarcane

Post-harvest trash removal effects on soil temperature and ratoon growth in green harvested sugarcane

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Abstract

Thick trash (harvest residue) layer left on soil surface after sugarcane green harvesting lowers soil temperature and slows down early ratoon growth on organic soils in Florida. These negative effects of trash may be minimized or avoided through partial or complete removal of trash immediately after harvesting. Additionally, the removed trash may be used for electricity or second-generation ethanol production.

To evaluate the effects of trash removal on soil temperature and sugarcane growth, a field experiment was conducted on organic soils (Histosols) with four treatments: 0%, 33%, 66% and 100% trash removal. The following data were collected: soil temperatures at 5 cm and 15 cm soil depths, number of tillers during early growth season, and final yield parameters at the time of harvest in first and second ratoon crops.

Results showed that the maximum soil temperature at 5 cm depth in first ratoon was significantly greater in 100% trash removal than all other treatments early in the season [<50 days after harvest (DAH)] with marginal or no difference later in the season. Tiller count also increased with 100% trash removal early in the season (<75 DAH), but there was no difference between the treatments later in the season (151 DAH). Soil temperatures and tiller counts in partial trash removal (33% and 66%) were similar to 0% trash removal. There was no significant treatment difference in tons of cane per hectare (TCH), sugar per ton of cane (SPT) and tons of sugar per hectare either in first or second ratoon.

Overall, only complete (100%) trash removal was helpful in increasing soil temperatures and improving early season growth in green harvested field but there was no effect on final sugarcane yield. Therefore, trash can potentially be left on soil surface as a mulch for soil conservation purposes or removed (partially or completely) for its alternate use without effecting sugarcane yields in ratoon crops.

Keywords: harvest residue, microclimate, yield, harvest system

Monday 24 Sep 2018

Session 2: Numerical agriculture and harvesting

Chairman: Dr. Troy Jensen

Oral presentation		
Pierre Todoroff	5	Automatic satellite image processing chain for near real-time sugarcane harvest monitoring
Posters		
César Arévalo	6	Comparisons of methods for sampling extraneous matter
Sandrine Auzoux	7	A dictionary of variables to harmonize data from agro-ecological experiments on sugarcane
Mathias Christina	8	Modelling sugarcane growth and yield using STICS model, parameterization and application in complex agro-systems
Alasdair Harris	9	Yield mapping in sugarcane - the step changer enabler
Alizé Mansuy	10	Three soil-cover scoring methods to assess cover crops between two sugarcane cycles
Kazuhiro Okuzawa	11	Improvement of sugarcane harvesting on sloping land by using a crawler cane harvester to extend the harvest period in rainy and dry seasons
Troy Jensen	12	Incorporating sugar loss data with other precision agriculture layers

Automatic satellite image processing chain for near real-time sugarcane harvest monitoring

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Abstract

Optimization of the productivity of sugar mills involves optimization of the logistics of sugarcane harvesting and milling operations. In many countries, sugarcane is produced by a multitude of growers with very poor access to information and communications technology. Hence, timely harvested area statistics are rarely available.

Yet, such data is crucial for sugar millers to adjust input supplies, allocate harvest equipment, manage cash flows, hire and manage staff, refine periods of operation, adjust yield prediction, etc. This presentation describes a sugarcane harvest monitoring system based on the processing of satellite image time series that produces harvest maps and harvested area statistics in near real-time.

We developed an optical image classifier and a radar classifier that produce binary maps of harvested vs non-harvested sugarcane areas at 10m resolution. Ground-truthing was achieved using a database associated with 147 fields. The data included the analyses of GPS tracks of harvesters, and Sentinel-1 (radar) and Sentinel-2 (optical) images from the ESA open data Copernicus Programme. We embedded the classifiers into a fully automated data processing chain running from the automatic download of available images over a study area, to the release on an online webmapping portal. This included pre-processing of the images: production of orthorectified backscatter radar images, and cloud free and bottom-of-atmosphere normalized difference vegetation index (NDVI) images.

Due to a combination of optical and radar images, and the short revisit-times of Sentinels satellites, the processing chain can produce harvest progress maps at desired intervals (a few days to weeks) regardless of cloud cover. As a result, this is frequent enough for decision making at mill level. It is based exclusively on open-source software (SNAP, SAGA GIS, PostGIS database, GDAL library, Linux bash shell, and QGIS server / QGIS web client for online publication) and runs on a Linux server. The data processing chain is therefore transferable without license costs. The processing time on an 8-core server is between 15 mins for radar image and 45 mins for optical images, including download time, which is acceptable for implementation on a small IT infrastructure. Moreover, the monitored site can cover several hundreds of thousands of square kilometers, making it a low cost and turnkey solution for near real-time monitoring of the harvest of a wide sugarcane production area.

Keywords: Open Source, open data, Sentinel, webmapping, radar

Comparisons of methods for sampling extraneous matter

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Abstract

Mechanical harvesting of sugarcane in Colombia has increased progressively in the last decade. In 2017, 60% of the sugarcane crop area was harvested mechanically and this percentage is expected to increase. Grab and core sampling are the current methods for measuring extraneous matter (EM) at the sugar mills. However, it is necessary to establish an in-field method for sampling EM that allows quick and accurate assessment of the effect of changes in the harvesting operation and condition of the crop. This will enable best practices to be identified, and consequently to improve the quality of the cane delivered to the mills. Partial results of comparisons between an in-field method, and grab and core sampling are presented in this poster.

The crop and mineral EM content of mechanically harvested green cane in seven transport trailers was evaluated. The number of trailer-loads evaluated is expected to increase to 12 by completion of the trial. Each trailer was loaded with cane from 120 m lengths of 15 rows (approximately 0.3 ha). This sampling strategy aimed to reduce the variability of the raw material inside each trailer. Six samples (59 kg +/- 24) for EM determination were collected directly from the elevator discharge during the loading of each trailer. Parameters such as ground speed, cutting height, primary extractor fan speed and length of the cane billets were kept constant during harvest of the 15 selected rows. Extraneous matter for each trailer-load was determined at the mill after collection of six core and six grab samples.

The results showed that the greatest variability occurred in the mineral EM, with coefficients of variation of 182%, 94% and 83% for the field, core and grab sampling respectively. In comparison, the coefficients of variation for crop and total EM ranged from 26% to 55%. The percentage of variation for the total EM determined between and in the trailers was calculated through a nested random effects analysis of variance. The highest percentage variation was found in the samples collected from inside the trailers (100%, 71% and 64% for the field, core and grab sampling respectively). The variation in EM therefore originated mainly inside the trailers and not between trailers.

Hitherto, the results reflected the high heterogeneity of EM, mainly inside the trailers. However, the current sampling frequencies used at the mills do not seem to reflect this heterogeneity. Due to these results, the number of samples collected in each trailer should be increased instead of increasing the number of trailers being sampled for current EM determinations at the mill. The EM in the remaining five trailers planned for the experiment will be evaluated and used to validate the in-field sampling method. Further research is also planned to assess the variability of the EM at plot scale.

Keywords: mechanized harvesting, extraneous matter, core sampling, grab sampling.

A dictionary of variables to harmonize data from agro-ecological experiments on sugarcane

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Abstract

With changing circumstances, sugarcane industries are adopting agro-ecological approaches to reduce environmental impacts of sugarcane production. These include fallow and/or companion crops cultivated in association with cane as alternatives to chemical weed control, organic material as substitutes for mineral fertilizer, and new cropping practices such as reduced tillage, crop rotation and crop diversification. Agro-ecological experiments generate many heterogeneous datasets that integrate functional biodiversity and multiple levels of spatial and temporal scales of observations. Each has its own structure. Observed variables include homonyms and synonyms. Units of measurement and methods of measurement are different or not specified. Plant and pest are identified and named in different ways.

To solve the problem of organization and standardization of these datasets, a controlled vocabulary was used for annotating data, increasing the accuracy of terms used by agronomists and harmonizing data capture. A dictionary of variables was developed using terms from reference ontologies such as plant physiology, anatomy, morphology, environmental science, ecosystems, habitats, agronomy, soil science, etc. Experts were involved throughout the process of creating the dictionary of variables. This included awareness of their data, details of the way they usually managed their data, and feedback from groups and individuals. The aim was to develop the dictionary of variables into a tool that could be integrated into daily practices. The main challenge was to reconcile agronomic and plant knowledge with data engineering, and to define a common language for close collaboration between agronomists and data scientists.

The structure of the dictionary of variables is based on the trait dictionary template used to develop crop ontology. A variable is defined by the combination of an entity, a trait, a method and a unit of measurement. The variables are classified by type (experimental design, plant, biological pest, soil, weather, crop management) and sub-type to describe the type more precisely (sub-type "physiology traits" for type "plant").

The dictionary of variables is continually being enriched by experts. It is used to support agronomists' field-books and to define the structure of agro-ecological experiment datasets. The resulting standardized datasets are made accessible to interested users and are easily reusable for modelling or statistical analyses. The dictionary of variables is useful for designing the structure of agro-ecological databases and especially to ensure interoperability with other agronomic databases. It can also be used as a tool to enhance and share expert knowledge.

Keywords: metadata, ontology, interoperability, heterogeneity

Modeling sugarcane growth and yield using STICS model, parameterization and applications in complex agro-systems

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Abstract

Sustainable and resilient sugarcane production requires agro-systems to improve nutrient use efficiency through nutrient recycling, reduced herbicide applications and reduced system outflows by erosion and/or leaching. In that context, crop models are particularly useful tools to assess the agronomic and environmental performances of simple (monoculture) or complex (multi-species) agro-systems. Among others, the STICS model, developed and applied in temperate climate, could be used to assess technical management in sugarcane tropical plantations.

In this study we present the STICS model parameterization and validation for two sugarcane cultivars (R570 and R579) using the CIRAD ECOFI database that includes about 100 monoculture trials on Reunion Island from 1995 to 2016. The model's ability to accurately simulate sugarcane yield and growth in more complex systems was assessed for different management scenarios using data from recent trials by contrasting: i) mineral fertilization regimes and organic residue applications, based on trials in the eRcane TERO project, and ii) multi-species cropping systems with cover crop, based on trials in the eRcane CanecoH project.

Despite being only recently applied in tropical areas and in sugarcane cropping systems, the STICS crop model appeared to be an accurate tool to simulate both monoculture and complex sugarcane agro-systems. Its successful combination with large-scale vegetation models, previously done in temperate areas, opens opportunities for the community of modelers of tropical agriculture to assess agronomic and environmental performances of sugarcane at regional scale in tropical areas.

Keywords: crop model, sugarcane, STICS model, fertilization, cover crop

Yield mapping in sugarcane – the step-change enabler

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Abstract

There are many pressures bearing down on the South African sugar industry ("the industry") from new pests such as the *Cacoscekes (Zelogenes) newmani* ("long horn beetle") to old foes such as *Eldana saccharina* ("eldana"), from slow moving tariff protection to a changing climate. These issues require attention or the industry could face further decline. The authors believe that yield mapping could provide the agricultural focus required to improve yields and optimise input cost efficiencies.

Two yield-mapping methodologies, that could be complimentary, were trialled and verified in June/July 2018 at the Shongweni sugar estate. The first utilises Lidar (light detection and ranging) technology. Geo-interpolation algorithms used in the forestry industry have been modified to produce sugarcane stalk height maps (developed on request by Land Resources International – LRI). This approach could provide an accurate proxy for sugarcane yield. The second utilises a load-sensor combined with spatial positioning technology (TopCon - LoadMaster) fitted to a mechanical loading unit ("MLU"). A yield map will be generated by interpolation of data points (load mass; GPS position) collected from the sugarcane extraction operation. Lidar, being a remote sensing technology, allows for stalk height variability to be identified and mapped prior to harvest, whereas load sensors on a MLU can only produce a yield map upon completion of the harvest extraction process. Ground truthing and calibration of both methods will be conducted. Accuracy, spatial resolution, utility and cost of both technologies is to be compared as a practical guide for the progressive farmer.

The above builds on initial work presented by the authors at the South African Sugar Technologists Association (SASTA) congress in 2017 on the need for yield mapping and initial results. Further to the trials to be conducted at Shongweni, the authors intend presenting the results from a repeat yield mapping exercise that was reported, including assessment of cane yield, variability in cane quality and therefore sugar yield. The methodology for this component of the research consists of mapping, with a GPS, the individual areas harvested by each sugarcane cutter, and then weighing the mass of each sugarcane stack. These data are then applied over the individual measured areas to create an intra-field yield map. Samples from each cutter stack will be extracted, weighed, and sent for laboratory testing to determine the individual quality parameters associated with the area cut by each cutter.

This research is novel and could lead to improved insights into the importance and potential for managing farming operations on an intra-field level. Yield mapping is considered by the authors to be the definitive agricultural scorecard and input prioritisation guide. Should lidar derived stalk height mapping prove to be a statistically accurate proxy for cane yield variability, then this could be an enabler for a step-change in the South African and global sugar industries.

Keywords: yield mapping, quality mapping, Lidar, load sensor, step-change

Three soil-cover scoring methods to assess cover crops between two sugarcane cycles

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Abstract

On Reunion Island, the sugar cane industry is seeking to improve its agricultural practices to methods that are more agro-ecologically based. Through a national plan of pesticide reduction, eRcane leads an experimental project that tests weed control methods between sugarcane crop cycles. Based on cover crop layout, such practices have a potential to reduce herbicide usage while preserving soil fertility (physical, chemical and biological properties). Soil-cover by weeds and cover plants is assessed by three scoring methods: (i) a visual method, (ii) a linear method based on a transect, and (iii) a drone method. The objective is to determine advantages and limitations of each method in terms of accuracy and pace at which it is achieved.

An experiment was carried out in 2015 in a farmer's field. Treatments compared the sowing of two cover plants, *Crotalaria juncea* and *Vigna unguiculata*, with control plots where cover crops were not sown between sugarcane crop cycles (the famer's practice). The trial was laid out in strip plots over a total area of 4 acres. The visual and linear scoring methods were performed by technicians every 20-25 days for 2.6 months, with qualitative and quantitative observations. The drone measurement was performed only once at the end of the test by a service provider. The image acquisition was done using both RGB (Red Green Blue) and near-infrared (NIR) images. An image analysis was used to compare the three methods.

The results show that the methods provided different information. Thus, on a plot with several vegetation strata, the linear method appeared to be the most accurate but most time-consuming. Visual scoring of soil-cover by vegetation, which is faster in the field, simplified data analysis but did not identify species under the upper vegetation stratum. The drone, on the other hand, widened observations of groundcover by vegetation to larger areas at greater speed but with lack of accuracy in differentiating species.

If visual and linear observations remain the most commonly used methods for assessing agricultural systems due to their accuracy levels, they imply constraints in terms of time and labor resources. The concept of precision farming and, in particular, aerial observation of crops by drones, remains an interesting approach at farm scale. Although good resolution images are obtainable with this method, there is a need for improvements in the algorithms that are used to differentiate a cover crop from a weed. Once these improvements have been made, it would be interesting to repeat this experiment for better comparisons.

Keywords: sugarcane, Reunion island, herbicide, cover crop, drone, scoring methods.

Improvement of sugarcane harvesting on sloping land by using a crawler cane harvester to extend the harvest period in rainy and dry seasons

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Abstract

Soil contact pressure by in-field machinery often causes compaction and reduces access to fields when soil moisture content is high.

A sugarcane harvester was therefore developed with low soil contact pressure. Testing in 2015 resulted in the following performance characteristics: a soil contact pressure of 43 kPa; an ability to operate at tilting angles over 25 degrees; measured yield losses below 10%; trash content below 13%; harvest weight 20 tons/hr; cutting length about 25cm, fuel consumption of 1.3 l/t; minimum rotational radius of about 5.6 m; and headland rotation time of about 60 sec. It has been in use since 2017.

The harvester was used on sandy soil in northeast Thailand and assessed in fields that yielded approximate 60 t/ha to 100 t/ha, including highly lodging cane. Harvesting was stable and its performance parameters (compared with those of existing medium-size models as shown in brackets) were as follows: 20 tonnes/hr (20 tonnes/hr) on average, yield loss ratio 8% (7%), trash ratio 8% (10% to 16%), cutting length 25 cm (20 cm), fuel consumption 1.3 l/tonne (2 l/tonne, headland rotation time 60 sec (90 sec).

It was also found that the new harvester is also less subject to tumbling in fields on sloping ground, is easy to handle in fields with irregular shapes or small upland fields, and is able to harvest high-yielding sugarcane and/or crops that are prone to lodging.

We concluded that the newly developed harvester is a useful option in northeast Thailand and may be suitable for many other areas that have similar characteristics/conditions.

Keywords: sugarcane, harvesting, mechanization, sloping land, extend the harvest season

Incorporating sugar loss data with other precision agriculture layers

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Abstract

Precision agriculture data layers detail the large variations in productivity across a sugar field. This changing yield, when presented to the chopper harvester, impacts on the machines ability to produce clean billets. The efficiency of the cleaning system can be manipulated by adjusting parameters such as extractor fan speeds, billet length and material fed rate. In general, these parameters are not continuously adjusted. Preliminary works by Whiteing & Norris (2002) investigated the relationship between harvester parameters and the range of sugar losses across the field. This was further refined with an improved method of detecting sugar loss (Whiteing, 2013) and a study of the impacts of nutrition (and hence pour rate) on sugar loss (Khawprateep 2017).

This paper reports on the marrying of precision agriculture data (obtained from yield monitoring equipment - Jensen *et al*. (2013)) with the point based sugar loss assessment, to expand the understanding of losses spatially across entire fields.

Keywords: precision agriculture, sugarcane, yield, sugar loss

Tuesday 25 Sep 2018

Field Trip North

Time	Place	Subject	Presenter
08:15 – 08:30	Hotel Le Récif	Access to bus - departure	-
08:30 – 09:30	-	Bus transfer	-
09:30 – 10:00	eRcane (Saint-Denis)	Welcome tea	
10:00 – 12:00		Visit	Bernard Siegmund Laurent Barau
	-	Bus transfer	-
12:00 – 13:00	Cirad (Saint-Denis)	LUNCH	Eric Jeuffrault
13:00 - 13:30	-	Bus transfer	-
13:30 – 16:15	La Mare (Sainte-Marie)	SOERE-PRO TERO Cover crop Weed management Glyphomulch	Charles Détaille Amélie Février Alizé Mansuy Vladimir Barbet
16:15		Return by bus	-

TERO Project

Local nutrient resources

Reunion Island produces large amounts of organic residues from agro-industrial, urban and agricultural sources, which can be an alternative to the large-scale import of inorganic fertilizers.

As the conditions for reasoned use of such resources when growing sugar cane have not been fully determined, a test project known as TERO has been developed to optimise their long-term usage and provide growers with technical advice.

Research process

The tests assess the agronomic interest of using organic matter by understanding the nitrogen efficiency of various organic residues on sugar cane cultivation in:

- estimating their overall nitrogen utilization efficiency (NUE) and nitrogen fertilizer equivalence coefficients (CE-N);
- distinguishing their direct and residual fertilising effect on sugarcane.

The program is being conducted at 4 sites in a variety of environments. Each site consists of three repeated treatments:

- non-organic treatments, from 0 to 150% of N (Urea) requirements,
- organic treatments applied at various dates and dosages:
  - 75% of requirements calculated and implemented every 2 or 3 years;
  - 37.5 % of requirements calculated and implemented every 2 or 3 years;
  - 75% of requirements calculated in the year of planting and implemented annually.

The non-organic treatments allow plotting of a nitrogen response curve in order to determine the NUE of the urea and organic matter, as well as the CE-N of the organic matter.



Site characteristics: La Mare:

The site of La Mare in Sainte-Marie is in the north of the island. Established in 2014, it extends over almost one hectare. The variety R582 s spray irrigated. The test will be carried out over two 7-year cane cycles, the first without mulch and the second with mulch.

Six different types of organic matter are being tested:

1. Filter Mud (FM)
2. Green Waste Compost (GWC)
3. Camp Pierrot Compost (CP)
4. Poultry Litter (PL)
5. Sewage Sludge (SS)
6. Pig Manure (PM)







SOERE PRO

A highly instrumented trial to study the environmental impacts of organic residue recycling in sugarcane ecosystems

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The SOERE-PRO (Observatory for monitoring and experimentation on agroecosystems fertilized with organic residues) is a long term field experiments network dedicated to the study of risks and benefits associated with organic residues usage. This network includes 4 main experimental sites in France equipped with sensors and monitoring material (La Mare, Reunion Island ; QualiAgro, Ile de France ; Colmar, Alsace ; EFELE, Bretagne). These sites are used to monitor closely the effects of organic residues application on the different compartments (soil, vegetation, water, air) of the agroecosystems. For some sites, this monitoring has been ongoing for more than 15 years.

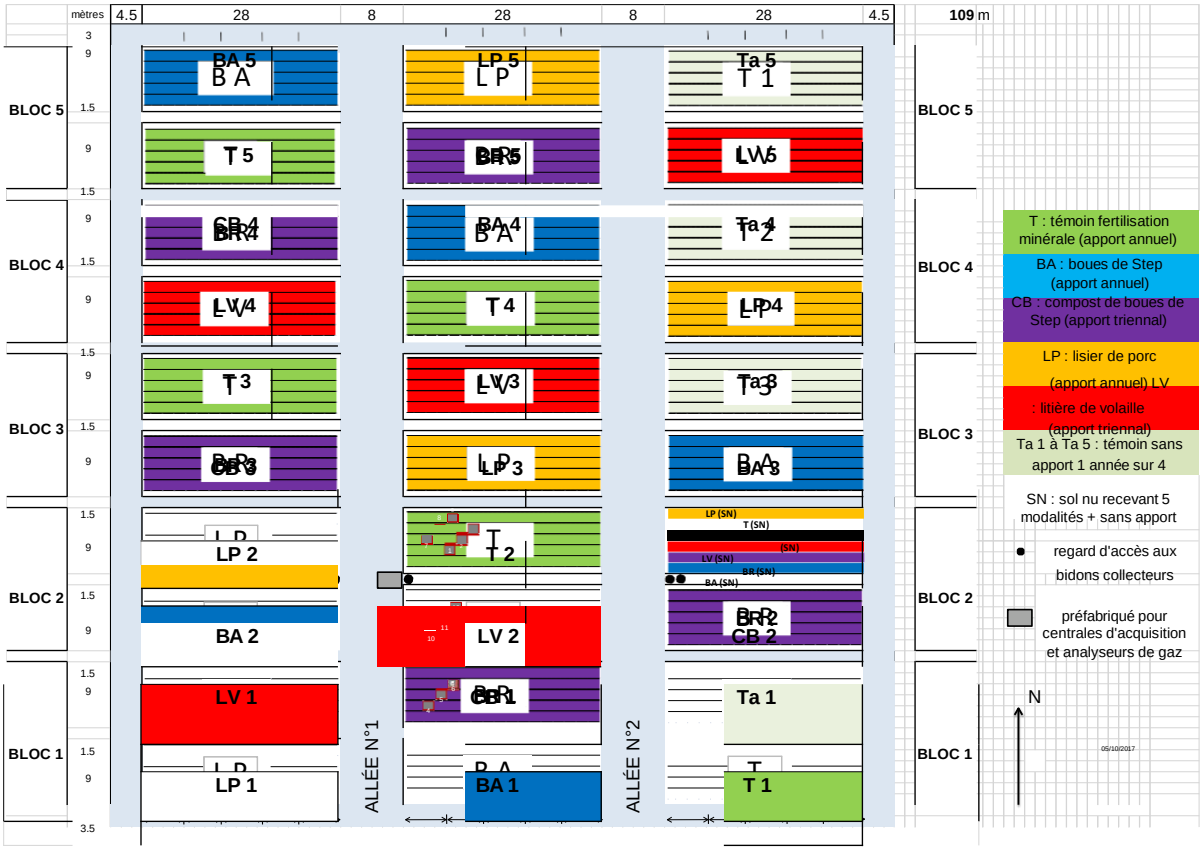
At SOERE-PRO Réunion, the following organic residues are applied to different plots of the sugarcane crop field: 1/ sludge pellets from Grand Prado waste water treatment plant, each year (BA); 2/ sludge compost from Grand Prado waste water treatment plant, every 4 years (CB); 3/ pig manure, each year (LP); 4/ poultry manure, every 4 years (LV).

The effect of these organic residues is then compared to mineral-based fertilization (N, P, K).

The field experiment was installed at « La Mare », a location in Reunion Island, in November 2013. Sugarcane was planted on a total area of 1.2 hectares, which includes 30 plots. Each plot has an area of 294 m^2, with dimensions 28m x 10m, and is organized in a randomized block design (5 blocks, 6 plots per block).

At SOERE-PRO Reunion, instrumentation includes mainly:

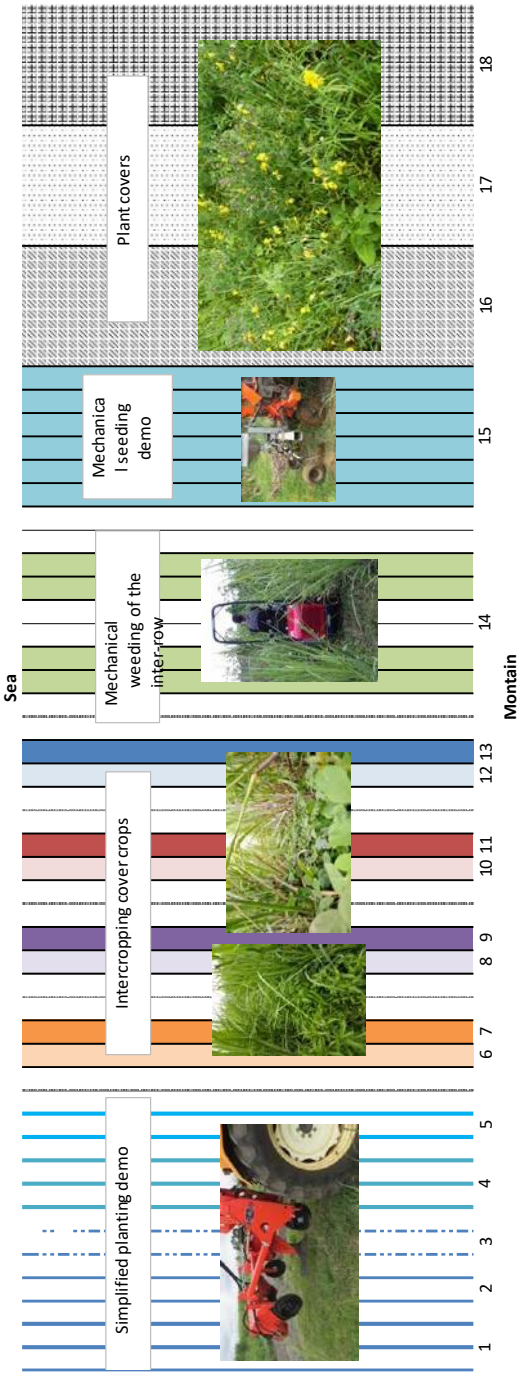
- TDR probes and tensiometers along the soil profile for soil water status monitoring
- Lysimeters and soil water samplers for soil circulating water collection
- Automated gas chambers, which close at regular intervals to measure gas fluxes in order to assess soil nitrous oxide (N2O) and carbon dioxide (CO2) emissions.
- NH_3 collectors (alpha badges) to estimate NH_3 volatilisation



Weed control – Mechanization & minimum tillage

Weeds are the main pest of cane in Reunion Island. Trials are being carried out to control weed growth while reducing herbicide consumption. Mechanical weeding and the use of intercropping covers crops are techniques that give encouraging results. Plant cover between two cane cycles is also an innovative and agro-environmental practice.

On the sloping soils of Reunion Island, tilling the soil for a new plantation puts the farmer at risk of erosion in the event of heavy rainfall.
The Glypho-mulch reduces the number of implement passages during soil preparation and the area worked. By working only on the old planted row, it also reduces the risk of stones rising to the surface.



Wednesday 26 Sep 2018

Session	Chair	Time	Presenter	Presentation
Session 3 **Soil organic carbon and alternative fertilisers**	Dr. Hardev Sandhu	**08:30 - 08:50**	Fernando Muñoz	Oral presentation 6
		08:50 - 09:25	Myriam Allo	Poster 13
			Amélie Février	Poster 14
			Virginie van de Kerchove	Poster 15
			Matthieu Bravin	Poster 16
			Antoine Versini	Poster 17
			Virginie van de Kerchove	Poster 18
			Duli Zhao	Poster 19
Session 4 **Weed management**	Dr. Fernando Muñoz	**09:30 - 09:50**	Azaad Gaungoo	Oral presentation 7
		09:50 - 10:20	Mathias Christina	Poster 20
			Emilie Fillols	Poster 21
			Emilie Fillols	Poster 22
			Azaad Gaungoo	Poster 23
			Calvin Odero	Poster 24
			Douglas Spaunhorst	Poster 25
		10:20 - 10:50	**MORNING TEA + POSTER VIEWING 3 & 4**	
Group activity		**10:50 - 12:20**	**WORKING SESSIONS n° 3 and 4**	
		12:20 - 13:50	**LUNCH**	
Session 5 **Nitrogen requirement and use efficiency**	Jean Robert Lincoln	**13:50 - 14:10**	Daniel Poultney	Oral presentation 8
		14:10 - 14:40	Toshihiko Anzai	Poster 26
			Bernard Schroeder	Poster 27
			Marion Ramos	Poster 28
			Bernard Schroeder	Poster 29
			Bernard Schroeder	Poster 30
			Amélie Février	Poster 31
		14:40 - 15:10	**AFTERNOON TEA + POSTER VIEWING 5**	
Group activity		**15:10 - 16:30**	**WORKING SESSIONS n°5 and cover crop**	
Robert Gilbert		**16:30 - 16:40**	**WRAP-UP FOR THE DAY**	
Emilie Fillols		**16:40 - 16:50**		

Wednesday 26 Sep 2018

Session 3: Soil organic carbon and alternative fertilisers

Chairman: Dr. Hardev Sandhu

Oral presentation		
Fernando Muñoz	6	Spatial distribution of labile and total soil organic C as influenced by sugarcane harvest residue management and soil texture
Posters		
Myriam Allo	13	High SOC stocks under sugarcane crops on volcanic soils of Reunion Island
Amélie Février	14	Partnerships aimed at adding value to organic matter on Reunion Island
Virginie van de Kerchove	15	The Ferti-Sol project: Acquisition of references and transfer via comparative fertilisation trials in sugarcane
Matthieu Bravin	16	Is application rate the only driver of phosphorus phytoavailability in tropical soils receiving mineral and organic fertilisers over an extended period?
Antoine Versini	17	Effects of organic residue application on the biogeochemical cycle of nitrogen in sugarcane agroecosystems in Reunion Island
Virginie van de Kerchove	18	An aid tool developed in Reunion to manage the fertilisation of sugarcane using local organic materials: Ferti-Run
Duli Zhao	19	Sugarcane yield response to soil amendments and N-P-K application

Spatial distribution of labile and total soil organic C as influenced by sugarcane harvest residue management and soil texture

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Abstract

Total soil organic carbon (t-SOC) expressed as soil organic matter (SOM) has traditionally been used as the main criterion for predicting nitrogen (N) requirement of sugarcane in Colombia. However, several research studies conducted by CENICANA have found that in many cases N application rates were overestimated when this method was used. SOC is composed of two main 'pools': active or labile SOC (l-SOC) and slow/passive SOC (sp-SOC). Although l-SOC is a small pool usually representing less than 4% of the t-SOC, it is associated with the availability of nutrients to the crop. Here we describe our advances in understanding the l-SOC pool variability in soil.

The investigation was conducted at a long-term research site where the effect of harvest residue management has been studied for almost 18 years. The area is divided into three zones: total remove of residue, double amount of residue, and regular amount of residue. In every cycle, the cane was harvested without burning. Undisturbed soil cores were collected at four soil depths (0-2, 10-12, 20-22, 40-42 cm) from 54 plots (18 in each area). Total SOC and l-SOC were determined on each sample using permanganate-oxidisable carbon methodology (POXC). The resulting dataset was mapped to show the spatial distribution of l-SOC and t-SOC over the entire residue management study site. This was then compared to maps showing the spatial distribution of soil texture.

Residue management clearly affected the spatial distribution of l-SOC. Where the residue was totally removed, the l-SOC content decreased in the 0–2, and 10-12 cm depths. The highest l-SOC was observed in the zone with the double amount of residue and at each of the sampling depths. The l-SOC content in the zone with regular amount of residues was intermediate to the other two zones. Soil texture was also found to affect l-SOC and t-SOC. This suggested that trash management options are affected by the interaction of harvest residue management and soil texture.

The results of this study show that POXC is a promising methodology for quantifying the effect of different management practices on the l-SOC pool that is comprised of rapidly cycling organic material. In contrast, the t-SOC pool is composed mainly of organic forms that decompose slowly. This tool may help to identify sites where it is possible to extract harvest residues for electricity cogeneration or, in future, to produce 2nd generation ethanol without risk of negative effects on the t-SOC/soil quality. The next step is to investigate the use of POXC in combination with mineralisable C to predict if a site has an ability to either accumulate/stabilize or mineralize SOC.

Keywords: total soil organic carbon (SOC), labile SOC, trash management

High SOC stocks under sugarcane crops on volcanic soils of Reunion Island

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Abstract

Volcanic soils of Reunion Island with high carbon (C) contents highlight the importance of 'carbon hotspots' to face the challenges of climate change and food security through C sequestration. In addition, the '4 per mille' initiative demonstrated that agricultural soils can play a crucial role for these global issues. Reunion, a young tropical volcanic island in the Indian Ocean, 700km east of Madagascar, presents a wide range of tropical soils on a volcanic rock-weathering gradient. Here, our work focused on the dynamics of soil organic carbon (SOC) contents in the different types of volcanic soils under sugarcane crops.

A large soils database consisting of information from more than 40 000 soil samples collected predominantly from sugarcane plots over the past 20 years was accessed for this study. Long-term diachronic series of SOC contents were extracted from the database. Georeferenced data combined with GIS tools were used to create a SOC map of Reunion. Data mining tools, such as boosted regression trees (BRT), were used to prioritize the drivers of SOC contents and evaluate the storage capacity of these young volcanic soils.

Soil type was the main driver of SOC content, ahead of climatic conditions and agricultural practices. As expected, Ferralsols, mostly located on the west and north coast, exhibited the lowest SOC content, whereas Andisols, at higher altitudes, showed the highest SOC contents for the 0-30cm layer. The long-term diachronic series also showed almost constant SOC under sugarcane crops over the full range of soils. In fact, sugarcane cropping systems produce high organic C inputs (residues and roots, 1.2 Mg C $ha^{-1}y^{-1}$) that are returned to the soil. This, combined with the C conservation practices in Reunion (no burning, mulching, one tillage every ten years on average), suggested that soil C saturation occurs under sugarcane crops for all soil types.

However, even though no more SOC storage is possible, several factors, such as land use change, could decrease the SOC that is stored in these soils. Preliminary results showed higher SOC stocks under sugarcane crops and pastures than in gardening plots for different soil types. Agricultural soils with high SOC stocks need to be preserved and agro-ecological practices need to be implemented in order to maintain/improve productivity and ecological resilience in farming systems.

Keywords: soil organic carbon, tropical volcanic soils, long-term diachronic series, sugarcane, soil analyses, database, data mining.

Partnerships aimed at adding value to organic matter on Reunion Island

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Abstract

The rational management of organic matter produced locally by agricultural, agro-industrial and urban units is a real challenge for Reunion Island. However, this organic matter represents an important opportunity for sugarcane farmers who are heavily dependent on the importation of mineral fertilisers. Four projects have been initiated to optimize the use of these resources from agronomic, economic and environmental perspectives.

These projects propose to answer four major questions about the optimal use of organic matter resources to replace mineral fertilisers either totally or partially: 1) what are the environmental impacts; 2) what are their fertilising properties; 3) how to optimize fertilisation advice to farmers; and 4) how to manage the available materials?

In response, CIRAD through the SOERE-PRO project, is assessing the environmental impacts of organic matter applications by means of a highly instrumented experimental system. This includes time domain reflectometry and use of tensiometers, lysimeters and an automated soil gas flux measurement system for N_2O and CO_2 determinations. This mechanism allows the impacts of organic matter to be followed within the soil, air, water and plant 'compartments'. At the same time, eRcane and CTICS, within the TERO project, are utilizing four test sites, corresponding to different soil and climate conditions, to characterize the composition of organic matter and evaluate their nitrogen (N) fertilising power. This will be done by determining apparent use coefficients and equivalences to fertiliser N. Closer to the farmers, the Ferti-Sol project of *La Chambre d'Agriculture* proposes to use soil analyses to develop balanced fertilisation trials with organic residues and mineral fertilisers. The use of these manures will be compared to the farmers' current fertilisation practices. The results will provide fertilisation advices that will allow for the farmers to improve their practices. Finally, in order to optimize the management of organic matter, the multi-partnership Gabir project, led by CIRAD, will analyze the biomass transfers between stakeholders. They will also simulate various valuation scenarios based on the principles of a circular economy.

These four projects are conducted in partnership and complementarity by the following research and development organizations: CIRAD, eRcane, CTICS and *Chambre d'Agriculture*. This initiative reflects Reunion Island's intention for sustainable management of the territory resources over the long term, especially through agriculture.

Keywords: sugarcane, organic matter, network, fertilisation, advice.

The Ferti-Sol project: Acquisition of references and transfer via comparative fertilisation trials in sugarcane

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Abstract

Reunion Island, with large areas of sugarcane, imports large quantities of mineral or synthesis fertilisers despite local organic residues that could be used as substitutes. The Chambre d'agriculture initiated the Ferti-Sol project in late 2016, as part of the French Network of Innovation and Agricultural Transfer (RITA). It aims to acquire information/data relating to the agronomic effects of fertilising sugarcane with local organic residues. Two trial sites cultivated by farmers are used for knowledge exchange between farmers, agricultural advisors and project partners. Here we present the methodology that was developed to achieve the two objectives of the project: acquisition and transfer of information.

The agronomic effects (cane yield, sugar content, soil monitoring) of three fertilisation strategies and fertilisation costs are compared. The trials continue for six years, which corresponds to the usual sugarcane production cycle in Reunion. It also provides sufficient time to assess the medium-term impacts of organic fertilisation.

Each trial is composed of three treatments within a randomised complete block design replicated three times:

- Treatment 1: mineral fertiliser used as a control and meeting 100% of the nutrient requirements (N, P_2O_5 and K_2O);
- Treatment 2: mixed fertilisation: local organic residue satisfying 100% of cane needs for at least one nutrient then adding, if necessary, a mineral supplement;
- Treatment 3: farmer's usual fertilisation practice.

The technical and economic information and knowledge that is acquired through these trials will make it possible to improve the technical advice relating to fertiliser practices to other farmers, through a 'knock-on' effect. The trial sites were therefore designed as places of information exchange between/among farmers, agricultural advisors, trainers and representatives of public authorities, technical institutes and research organizations.

Communication actions (publication of articles, broadcast of reports on the project on local television, sharing of information via the website http://www.mvad-reunion.org/, etc.) are also organized to reach a wider audience.

The Ferti-Sol project aims to promote the establishment of a 'circular economy' through value-adding to locally available organic fertilizer residues, while preserving the environment and the agronomic potential of soils.

Keywords: comparative fertilisation trials, farmers' field trials, organic fertilisation, sugar cane

Is application rate the only driver of phosphorus phytoavailability in tropical soils receiving mineral and organic fertilizers over an extended period?

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Abstract

Application of organic residues (OR) on agricultural soils could reduce the use of mineral phosphorus (P) fertilizers, but the efficiency of OR to meet crop requirements will need to be determined. We thus aimed to study mechanisms determining the effects of OR on P bioavailability to plants (phytoavailability).

Our work was based on five field trials on Reunion Island that included organic and mineral fertiliser applied over a decade, incubations studies and plant growth experiments under controlled conditions. Available inorganic P (Pi) and organic P (Po) was determined using extractions with deionised water and alkaline sodium bicarbonate solution (Olsen), diffusive gradients in thin films technique (DGT) and isotopic dilution associated with anion exchange membranes (EAEM). Phytoavailable P was defined as the P taken up by the plant. Soil Pi sorption capacity was determined using sorption curves.

For all soil types studied (Andosol, Andic Cambisol, Nitisol, and Arenosol), RO mainly increased the available Pi, but had little effect on available Po. This suggests that mineralization of Po applied with RO does not limit Pi availability. Application of RO increased available Pi mainly by increasing soil pH and consequently by decreasing soil Pi sorption capacity. Phytoavailable P increased with soil available Pi, but decreased with increasing soil pH.

Our work suggests that except for the amount of P applied, RO mainly affects P phytoavailability by changes in soil pH.

Keywords: phosphorous, soil P test, organic residue, organic wastes, P availability, soil pH

Effects of organic residue application on the biogeochemical cycle of nitrogen in sugarcane agroecosystems on Reunion Island

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Abstract

Reunion Island is a densely populated Overseas Territory of France in the Indian Ocean. There is an increasing need for waste management, given the rising population density and the associated increase in waste production. This waste can take the form of human waste (sewage sludge) and livestock waste (animal manure). The primary means of adding value to this waste would be to use it as organic fertiliser in agroecosystems. Sugarcane is the most abundant crop on the island - 54 % of the 43 000 hectares allocated as agricultural land, across 9272 farms. Recycling agricultural waste can be a means of improving the economic sustainability of sugarcane plantations, as local products are recycled and the quantity of fertiliser imported is reduced. This in turn promotes a circular economy on the island.

Nitrogen (N) is an essential nutrient for crop growth and development, and is frequently a limiting factor in sugarcane agroecosystems. Despite the clear benefits of N fertilisers in contributing to adequate crop nutrition, excessive amounts accumulated in terrestrial and aquatic ecosystems can lead to a significant impact on environmental quality, ecosystems, biodiversity and human health. Environmental impacts linked to the N cycle include the loss of N to the atmosphere in the form of NH_3 during the process of volatilization and in the form of the greenhouse gas N_2O during the process of nitrification and denitrification. Excess N is lost via leaching in the form of nitrates, which can lead to negative impacts on freshwater ecosystems.

Here we present the findings of one-complete-year monitoring of nitrogen fluxes (N uptake, N_2O and NO_3) in sugarcane plots fertilized with liquid pig manure and sewage sludge as compared with the use of urea fertiliser.

The study is being conducted on Reunion Island in a long-term monitoring field trial site belonging to the SOERE-PRO network, where the objective is to observe the effects of organic residue application on the different 'compartments' of a sugarcane agroecosystem. The contribution of organic residues to N sugarcane (nitrogen recovery efficiency) was assessed on a monthly basis using ^{15}N labelling, dilution curves, cane inventories (height and basal diameter) and allometric relationships. The annual flux of N_2O was estimated for the different treatments using 12 automatic chambers linked to a gas analyser. These semi-continuous measures allowed the temporal variability of N_2O emissions to be studied, in the original context of organic residue application in tropical conditions. Dissolved organic nitrogen (DON), NH_4 and NO_3 leaching in the soil was studied using a mixed system, consisting of porous cups under tension at depths of 10 and 40 cm; and lysimetric plates at a depth of 1m.

Keywords: N_2O emissions, NO_3 lixiviation, Nitrogen Use efficiency, Sugarcane

An aid tool developed in Reunion to manage the fertilisation of sugarcane using local organic materials: Ferti-Run

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Abstract

In Reunion, the Chamber of Agriculture promotes the use of local organic fertilisers for growing sugarcane – the predominant crop on the island.

To reach this objective, it is crucial to strengthen technical advice given to farmers and to improve farmers' fertilisation practices. In 2007, Cirad and the Chamber of Agriculture created Ferti-Run, a tool to help farmers improve the fertilisation of their crops. This tool allows rapid identification of fertiliser requirement using local organic materials. Ferti-Run was made available online in 2018. Here we present the operating principles that underpin this tool.

Users of Ferti-Run choose the crop they need to fertilise: sugarcane, temperate fodder, 20 types of vegetables and five fruits. They can then select an organic material from the list of 26 possibilities that are characterized for Reunion Island. The area of the plot to be fertilised is identified, as well as the type of soil on which the crop is grown. The tool automatically calculates the amount of organic fertiliser needed to best meet the nutrient requirements of the selected crop. In 2018, a new feature was introduced to meet users' needs. It now includes the possibility to add a mineral or synthesis fertiliser, in addition to organic material.

To calculate the fertiliser application rate, Ferti-Run integrates the area of the cultivated plot, the yield objective and the nutrient requirements of the crop, the soil type and the agronomic characteristics of the organic material. The tool produces a specific report for the cultivated plot and provides the requirements per hectare. The report shows the following: nutrient requirements, amount of organic material needed and nutrients supplied, amount of fertiliser to be supplied with corresponding nutrients, and, if applicable, the nutrient deficit to reach 100% of requirements of the crop.

Ferti-Run is updated regularly based on any new and/or additional science-based information. Available free of charge, it is accessible online or may be downloaded from the Chamber of Agriculture website (www.mvad-reunion.org).

Based on information specific to Reunion Island, this aid tool for mixed fertilisers could also serve as a model for other sugarcane-producing countries, given the simplicity of the underlying framework. For this to occur, the underpinning data will need to be replaced with locally-derived information such as nutrients requirements of the crop, N, P and K contents of products, corresponding fertiliser equivalence coefficients of the available organic materials, and the soils characteristics that impact on the nutrient requirements of the crop.

Keywords: advice tool, aid decision tool, organic fertilisation, sugar cane, Reunion Island

Sugarcane yield response to soil amendments and N-P-K applications

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Abstract

A field study was conducted on a sandy soil in Florida, USA to investigate effects of organic amendments and N-P-K fertilizer combinations on sugarcane (cv. CP 78-1628) yield and yield components. Three soil amendment treatments were: (1) control (no amendment added), (2) poultry litter compost (Cal Maine), and (3) mill mud (Cachaza). Three contrasting levels of each N-P-K element included a zero amount (0x), a fully recommended amount (1x), and a half recommended amount (0.5x). Eight N-P-K treatments were 0x-0x-0x, 1x-1x-1x, 0x-1x-1x, 0.5x-1x-1x, 1x-0x-1x, 1x-0.5x-1x, 1x-1x-0x, and 1x-1x-0.5x. The experiment was a split plot design with six replications. “Soil amendment” was the main-plot factor and applied before planting. The N-P-K rate combination was the subplot factor, with split applications at planting and during tillering.

Both the soil amendment and the N-P-K rate significantly affected the normalized difference vegetation index (NDVI) measured at grand growth stage, and cane and sucrose yields. The soil amendment slightly decreased commercial recoverable sucrose (CRS), while the different N-P-K combinations did not affect CRS. There was no interaction between the soil amendment and N-P-K combination in yield traits measured. When data from the plant cane and first ratoon crops were averaged, it was found that stalk population, mean stalk weight, cane yield, CRS, and sucrose yield increased by 9.8, 13.8, 24.7, -3.1, and 20.1% respectively by Cal Maine and 4.6, 10.7, 15.5, -2.4, and 12.9%, respectively by Cachaza, compared with the control. Application of N and K positively improved sugarcane yield and yield components except for CRS. Among the eight N-P-K combination treatments, 1x-0.5x-1x and 1x-0x-1x resulted in the highest NDVI and yields. Cane and sucrose yields were highly and positively correlated with NDVI ($r = 0.915^{***}$ and 0.900^{***}, respectively, $n = 48$).

It was concluded that using soil amendment with reduction in P application could improve sugarcane yields and production in the Florida sand soils. Sugarcane yields could be predicted using NDVI.

Keywords: soil organic amendment, N-P-K fertilizer, NDVI, yields

Wednesday 26 Sep 2018

Session 4: Weed management

Chairman: Dr. Fernando Muñoz

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WIKWIO Portal: An online resource on weeds for sugarcane growers

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Abstract

Efficient control of weeds is only achievable through a clear and sound knowledge of their biology and ecology. The Weed Identification and Knowledge in the Western Indian Ocean (WIKWIO) portal (http://portal.wikwio.org/) has been developed to meet this objective. It aims at building and leveraging a science and technology network to consolidate existing scientific and technical knowledge, and facilitating the sharing of new information. Although the portal currently covers the Indian Ocean region, most of the tropical weeds that are documented are also present in many other sugarcane-producing countries. This paper highlights the benefits that this resource can have to growers for managing weeds in their fields.

The WIKWIO portal is the outcome of a three-year collaboration among weed scientists of CIRAD (France), CNDRS (Comoros), FOFIFA (Madagascar), IFP (India) and MSIRI (Mauritius). A community of stakeholders involved in weed knowledge and management, also collaborated in the action. Experts from the six research institutions worked on a list of nearly 470 species of tropical weeds. They compiled and validated information on the biology, ecology, distribution, agronomic importance and management of each weed species in datasheets in both English and French. Each weed has been fully illustrated with high-resolution pictures and scanned herbarium sheets to provide additional details. Botanists and computer engineers set up an information system to host these data, in addition to other tools that facilitate rapid weed recognition and documentation.

The portal became operational in early 2014 and was improved with various options at the completion of the project in February 2017. More than 750 users have registered on the WIKWIO network, contributing over 10,000 observations of weeds, many of them encountered in sugarcane fields in various parts of the world. All the observations posted on the website are geo-referenced, thus providing useful data on their ecological distribution. Identified species are linked to the appropriate datasheets, giving insights into their management and control. Weed identification is possible via a computer-aided tool (IDAO) available on the portal. This resource and the possibility of uploading observations onto the network are accessible through applications (apps) on mobile devices enabling easy use in the field for rapid weed control decision and intervention.

The WIKWIO portal enhances a collaborative and participative approach by sharing knowledge and providing practical information. It can serve as a platform for establishing and reinforcing a community of sugarcane growers seeking help or exchanging experience on weed management issues. Nowadays, with the easy and rapid access to internet connectivity, timely assistance may be obtained through the portal. The latter takes place in a 'numerical agriculture' approach that is expected to evolve into a website for tropical weeds.

Keywords: weed identification and management, collaborative and participative approach, network of users, information sharing

Crop cover selection to improve weed control in sugarcane agrosystems on Reunion Island

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Abstract

Cover crops are increasingly being used for weed management in tropical regions as an alternative to herbicides. However, selecting the most suitable cover crop to be associated with a main crop requires long-term investigation. Here we present details of a set of trials conducted over two years to assess the ability of various cover crops to limit weed growth in sugarcane agrosystems.

Firstly, 55 species/varieties were assessed in terms of their growth cycle and viability at three different locations in tropical conditions on Reunion Island. This trial allowed selection of cover crop species that would be suitable for either rotational cropping or intercropping with sugarcane.

Secondly, 10 species were selected and grown in large plots in four different trials. This allowed for assessment of their ability to limit weed growth in monospecific plots and where mixtures of cover crops were grown.

After two months of growth, the most productive cover crops showed the ability to limit weed growth to fewer than 30% of the plot (e.g. crotalaria, oat and millet). The less productive cover crops were unsuccessful in limiting weeds. In comparison, all combinations of two cover crops tested in this experiment were able to limit weed growth to fewer than 30% of the plot area.

These trials highlight some key cover crops that are suitable for intercropping and rotations in sugarcane agrosystems as alternative to herbicides.

Keywords: weed control, cover crop, multi-species, sugarcane, Reunion

Can directed spray strategies control established Guinea grass?

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Abstract

Perennial grasses like Guinea grass (*Panicum maximum*) are particularly troublesome in sugarcane farming systems. Seed germination is well controlled by a range of pre-emergent herbicides, and emerged Guinea grass at an early stage is easily managed with knockdowns. However, escapes are frequent and established Guinea grass stools are commonly found in cane paddocks. These escapes are often due to weather conditions limiting paddock accessibility at appropriate spraying time, or limited efficacy of the pre-emergent herbicides. Control of established Guinea grass stools is difficult as effective herbicides are not cane selective, and growers often rely on spot spraying, which is time consuming. Trials were established to identify if directed spray strategies are effective on Guinea grass and safe for sugarcane.

Four replicated field trials were conducted in the Queensland Wet Tropics in trash blanketed ratoons to compare the efficacy of a range of herbicide treatments and directed spray methods. Treatments included:

T1: an early banded spray with asulam (3400 g ha^{-1}), followed by a late interrow application of glyphosate (2700 g ha^{-1}) using a shielded sprayer.

T2: a late application of diuron (450 g ha^{-1}) + paraquat (300 g ha^{-1}) using an octopus leg.

T3: a late application of isoxaflutole (75 g ha^{-1}) + paraquat (300 g ha^{-1}) using an octopus leg.

T4: a late application of isoxaflutole (75 g ha^{-1}) + MSMA (2160 g ha^{-1}) using an octopus leg.

T5: a late application of isoxaflutole (75 g ha^{-1}) + MSMA (2160 g ha^{-1}) in the row and glyphosate (2700 g ha^{-1}) in the interrow, using a dual tank shielded sprayer with side nozzles.

T6: a late application of isoxaflutole (75 g ha^{-1}) + MSMA (2160 g ha^{-1}) in the row and glyphosate (2700 g ha^{-1}) in the interrow, using a dual herbicide spray bar (no shield).

Visual ratings on cane and grasses were performed every second week (rating scale: 1 to 9, maximum severity = 9), the number of grass stools were counted before spraying and after harvest to calculate a percentage grass reduction and cane yield was measured using a weigh truck.

Treatments T4 and T5 generated stronger phytotoxicity symptoms on the grasses in the row (ratings >5), compared to T1 and T2 (ratings =3). Treatment T4 reduced by 67% the number of grasses in two trials, and tended to be the most effective long-term option. Treatments T1, T5 and T6 involving glyphosate controlled the grasses in the interrow (ratings average >7.5), whereas treatments T2 and T3 had the lowest visible impact (ratings average <6). Treatments T3, T4 and T5 involving isoxaflutole + paraquat or MSMA in the row, generated the strongest phytotoxicity symptoms on cane (ratings average >2.6), compared to T1 and T6 (ratings <1.9). Treatments T3, T4, T5 and T6 significantly reduced cane yield by 34 to 42% compared to T1. Even if treatments T4 and T5 were the most effective on grasses, these treatments were too detrimental to cane yield to be recommended.

No directed spray strategies were identified to control safely established Guinea grass in cane rows.

Keywords: Guinea grass, directed spray, herbicide

Using cover crops to manage weeds

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Abstract

In 2006, the Sugar Yield Decline Joint Venture (SYDJV) proposed a farming system that included a legume fallow to maximise cane productivity (Garside and Bell 2006). By 2018, 56% of sugarcane growers grow fallow crops (results of 2017 SRA growers survey). Soil health improvement and nitrogen supply from the fallow crop residues were the main benefits highlighted by the SYDJV. However, the potential additional benefit of cover crops as a weed control mechanism was not studied, and could be a driver for further adoption. Here we present the findings of field trials investigating the weed control potential of several cover crops and blends adapted to different cane farming systems.

Two preliminary replicated split plot trials were implemented in fallow blocks in Far North Queensland in 2013. Treatments compared Ebony cowpea (*Vigna unguiculata*), Rongai lablab (*Dolichos lablab*), a blend of cowpea-lablab (50/50, W/W), a blend of cowpea-lablab-Jack bean (*Canavalia ensiformis*) (40/20/20) and a blend of cowpea-lablab-Shirohie millet (*Echinochloa esculenta*) (40/40/20). Each treatment was tested at two sowing rates (70 and 140 $kg.ha^{-1}$) and managed with and without herbicides. Weed coverage assessments indicated that the best cover crops to reduce weed coverage were cowpea alone, cowpea-lablab and cowpea-lablab-millet. They all maintained the weed coverage below 8%. The high sowing rate increased the speed of cover crop establishment and decreased the amount of weeds by up to three fold compared to the standard sowing rate, making the use of herbicide unnecessary at that rate.

From these findings, two replicated split plot trials were established in 2014 that compared cowpea, cowpea-lablab (50/50) and cowpea-lablab-millet (40/40/20) planted at 140 $kg.ha^{-1}$ without herbicides versus a bare fallow treatment. Each treatment was tested in no till, zonal till and full tillage systems.

Cowpea and cowpea-lablab-millet were the best weed control options in the three tillage systems and maintained weeds below 20% weed coverage, provided that the cover crops were sown before weed germination in the minimum tillage systems. In one trial, extreme wet conditions (400 mm rain in ten days) were more challenging for the establishment of Rongai lablab compared to Ebony cowpea, especially in the full till system, and the weeds took advantage (up to 32% weed coverage in cowpea-lablab treatment versus 15% in cowpea alone). The blend of cowpea-lablab-millet performed well in all farming systems (except in waterlogged conditions) and maintained the weed coverage below 3%. The early germinating millet outcompeted the weeds in the early stages after sowing, while the legumes emerged a few weeks later. Bare soil fallow was also an effective management alternative when the weeds were controlled on time before seeding. Bare fallows require multiple herbicide applications, which are prone to contaminate watercourses, or multiple tillage operations, which increase the risk of erosion.

The trials highlighted that fallow crops can be optimised for weed control in sugarcane fallows. More fallow crop blends need to be investigated for their weed control properties and performance in other sugarcane districts.

Keywords: cover crops, cowpea, lablab, millet, weed management

Integrating strategies to manage large-seeded vine weeds in sugarcane fields

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Abstract

Large-seeded weeds (diameter > 2 mm), with larger reserves, are able to germinate and emerge from a soil depth of more than 6 cm or from beneath a sugarcane trash blanket. Changing cultural practices and conditions have contributed to agro-ecological circumstances that favour the frequent occurrence of vine weeds and shrubs in sugarcane fields across Mauritius. Unfortunately, current management practices are either unable to provide satisfactory control or are too costly. Research was initiated to explore and find solutions to the problem. This has included germination, emergence and development of these weeds integrated with several practices such as choice of herbicides, higher spray volume, trash management and new spraying techniques. This paper reports on the progress achieved.

Several trials during the last three years evaluated the impact of each of the modified practices and their integration on the overall management of vine weeds. Herbicide sulfentrazone at 1.5 kg a.i. ha^{-1} was evaluated with pre- and early post-emergence of vines and sugarcane. The efficacy of control of various trash management practices was investigated in trials where the trash was windrowed on the interrows to have a thicker mulch, while herbicide applications were directed on the cleared cane rows only. The use of higher spray volume was assessed by applying the herbicide treatments through a pivot irrigator (herbigation with approx. 60,000 L ha^{-1}) or by using higher delivering nozzles (1100-1500 L ha^{-1}) on a boom sprayer. More recently, trials have also been used to investigate the benefits of using high-clearance (180 m) sprayers for the control of vines in tall cane. The main vine species present in most of the sites was *Ipomoea triloba*.

Herbicide sulfentrazone sprayed just after planting with an application volume of 1350 L ha^{-1} was 33% more effective in controlling *I. triloba.* An early post-emergence spray (1150 L ha^{-1}) knocked down all the emerged seedlings and kept the weed under control until cane canopy closure. While the efficacy of sulfentrazone was maintained when directed on cane rows, the thicker trash layer was successful in suppressing weed emergence in the inter-rows. Herbigation and high-clearance spray equipment indicated potential for managing emergence from large seeds and eradicating vine weed in developed sugarcane, respectively.

Pre-emergence herbicides are mostly effective on germinating seeds found in the upper layer (0 - 4 cm) of the soil profile. Large-seeded weeds germinating and emerging from a deeper profile will escape the herbicidal effect. Management of such weeds require an integrated approach; the right herbicides may need to be applied with a higher spray volume using appropriate application technologies. The timing of spraying and the positioning of the sugarcane mulch are also important considerations to ensure efficient control of the weeds. Trials are underway to validate the integrated strategies and their cost-effectiveness.

Keywords: sulfentrazone, spray volume, trash mulch, spraying technology

Field dissipation of soil-applied sugarcane herbicides on organic soil

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Abstract

Sugarcane is grown primarily on organic or muck soils (Histosols) in the Everglades Agricultural Area in Florida. Efficacious weed control in these soils with preemergence herbicides at planting or following harvest of ratoon cane is essential for profitable sugarcane production. Triazine herbicides, atrazine and metribuzin applied in combination with pendimethalin are widely used for preemergence broadleaf weed and grass control, respectively. Efficacious residual weed control by these herbicides depends on their persistence in soil under field conditions. Field studies were conducted between 2011 to 2012 to determine dissipation of atrazine, metribuzin, and pendimethalin applied preemergence on organic soils.

The soil type was Dania muck with pH of 6.6 to 7.1 and 64 to 77% organic matter. The experiments for each herbicide were arranged in a randomized complete block design with three to four replication of herbicide treatments. Treatments consisted of atrazine, metribuzin, and pendimethalin applied at 4.48, 1.12, and 4.0 kg/ha, respectively. Pendimethalin was applied both as oil- and water-based formulations. Soil samples were collected from the top 10 cm of soil immediately after application and then every 7 days for a duration of 8 weeks, then stored at -20 C prior to analysis. The herbicides were extracted using toluene and the concentrations in the toluene phase determined using a gas chromatograph-mass spectrometer.

Herbicide dissipation data were fitted to exponential decay models to determine their half-lives under field conditions. Both total amount and bioavailable fraction of atrazine dissipated rapidly. The half-life of the total amount and bioavailable fraction of atrazine ranged from 4 to 10 days and 1 to 6 days, respectively. Dissipation of the total amount of metribuzin increased over time and the half-life ranged from 19 to 25 days, while the half-life of the bioavailable fraction ranged from 9 to 11 days. Both the oil- and water-based formulations of pendimethalin had biphasic rates of dissipation. The half-life of the oil- and water-based formulations were 8 to 18 days and 12 to 13 days, respectively.

Atrazine dissipated more rapidly than metribuzin under field conditions in organic soils. Atrazine half-life values were up to 60-fold lower than previous estimates of 60 days under field conditions, indicating enhanced degradation, resulting in shorter residual activity. This implies that metribuzin is a better option for use on organic soils exhibiting enhanced atrazine degradation. Dissipation of oil- and water-based pendimethalin formulations were very similar, but with lower half-lives. The lower values were attributed to climatic and edaphic conditions, and the absence of incorporation following application, suggesting that long residual activity of pendimethalin irrespective of the formulation when applied under dry soil conditions with no incorporation will not be observed on organic soils.

Keywords: field dissipation, enhanced degradation, residual activity, organic soil.

Influence of topramezone plus triclopyr mixtures and application timing on bermudagrass control in sugarcane

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Abstract

Bermudagrass remains one of the most troublesome perennial weeds to control in sugarcane. Previous research has shown increased herbicidal activity with mixtures of topramezone plus triclopyr on bermudagrass in tall fescue turf. Limited data is available on sugarcane yield response and bermudagrass control with topramezone plus triclopyr mixtures.

The first objective of this study was to evaluate the single herbicide treatments: topramezone (24.5 g ai ha^{-1}) plus triclopyr (1,130 g ae ha^{-1}), topramezone (24.5 g ai ha^{-1}) plus triclopyr (1,130 g ae ha^{-1}) plus asulam (1,850 g ae ha^{-1}), and topramezone (24.5 g ai ha^{-1}) plus triclopyr (1,130 g ae ha^{-1}) plus trifloxysulfuron (15.8 g ai ha^{-1}). A sequential treatment of topramezone (24.5 g ai ha^{-1}) plus triclopyr (1,130 g ae ha^{-1}) was applied 3 weeks after treatment to plots that were treated to the previously listed herbicide mixtures, and bermudagrass control was evaluated. The second objective was to determine if bermudagrass infestation level at the time of herbicide treatment influences herbicide efficacy for control of bermudagrass and sugarcane yield components and the third objective was to evaluate if additional bermudagrass control can be achieved with the addition of asulam or tryfloxysulfuron to topramezone plus tryclopyr to create a three-way herbicide mixture.

Sequential herbicide treatments reduced green bermudagrass biomass and bermudagrass cover 4 and 43% more than single herbicide treatments, respectively, and had no negative impact on sugarcane yield and sucrose yield. Delaying the herbicide treatment timing until bermudagrass infestation reached 100% resulted in 21% less green bermudagrass biomass compared to herbicide treatments applied at 25% bermudagrass infestation. Increased control is likely attributed to having less time for bermudagrass to recover from the herbicide treatment before the row middles were shaded out by the crop canopy.

Sucrose yield is a function of theoretical recoverable sucrose and sugarcane biomass yield. Herbicide treatments did not reduce sugarcane yield, but some treatments reduced sucrose yield. The three-way mixture of topramezone plus triclopyr plus asulam resulted in 11% greater sucrose yield than the two-way topramazone plus triclopyr mixture, but was similar to the topramezone plus triclopyr plus trifloxysulfuron mixture. Results from this study show plant cane (cultivar L 01-299) is highly tolerant to bermudagrass competition, as sucrose yield recorded from the nontreated check was equal to or greater than sucrose yields from herbicide treated plots.

Additional research is needed to determine the effect of bermudagrass competition on subsequent ratoon yield and to evaluate other commonly planted sugarcane cultivars yield response to topramezone plus triclopyr mixtures.

Keywords: Bermudagrass, herbicides, sugarcane

Wednesday 26 Sep 2018

Session 5: Nitrogen requirement and use efficiency

Chairman: Jean Robert Lincoln

Oral presentation		
Daniel Poultney	8	Non-destructive sampling procedures for studying nitrogen use efficiency throughout the sugarcane crop growth cycle
Posters		
Toshihiko Anzai	26	Effect of different fertiliser application management strategies on leaching of nutrients and sugarcane yields on Negros Island, the Philippines
Bernard Schroeder	27	Developing soil-specific nutrient management guidelines for sugarcane grown on rejuvenating volcanic-alluvial soils in Nicaragua
Marion Ramos	28	Soil spectral signatures for sugarcane fertiliser recommendations through an adapted soil typology
Bernard Schroeder	29	Questioning the role of crop size in determining sugarcane nitrogen fertiliser requirements
Bernard Schroeder	30	Some early lessons from field trials using enhanced efficiency fertilisers
Amélie Février	31	Variability of nitrogen use efficiency of urea in Reunion

Non-destructive sampling procedures for studying nitrogen use efficiency throughout the sugarcane crop growth cycle

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Abstract

Nitrogen (N) is a fundamental nutrient in agroecosystems, but has considerable negative environmental impact when used in excess. Meeting N demand while reducing excess N can be achieved by improvements in N use efficiency (NUE) of a crop agroecosystem. This is generally determined destructively (i.e. by cutting the cane) at the end of the crop cycle during harvest, where NUE is typically higher than during initial phases of crop development. Here we present the findings of a methodological study that aimed at developing non-destructive estimations of NUE throughout the crop cycle.

We investigated the ability of allometric relationships to estimate sugarcane biomass by testing different functions and measurable traits (cane height and basal diameter) on six sampling dates. A dilution curve was constructed to predict N content of the sugarcane biomass by harvesting 20 stalks of cane on five separate dates. The number of harvested stalks was then rationalised to reduce the amount of harvested cane without affecting the ability of the curve to predict N content. As N derived from fertiliser (Ndff) can be determined from a representative leaf using an ^{15}N-labelling approach, ^{15}N content of each leaf on three stalks of cane was determined on four sampling dates. This enabled identification of the most representative leaf for determining ^{15}N content of the biomass.

The percentage difference and the associated error between sugarcane biomass predicted by allometric models and 2.5m harvested plots varied depending on the combinations of measurable traits used for the allometric relationships. The values for cane: 1) height on each date; 2) height x diameter on each date; and 3) height x diameter using a global relationship across sampling dates was 2±3 %, 2±3 % and 5±3 % respectively. In order to construct an adequate dilution curve, we determined statistically that a minimum of 5 sugarcanes needed to be sampled. The leaf with an ^{15}N content most representative of the entire cane aboveground biomass was L+1 at 3, 8 and 11 months and L+3 at 5 months of growth (L+1 is the first leaf from the top with a visible dewlap).

Allometric relationships appear to predict sugarcane biomass effectively at a plot scale. Models developed for each month may provide slightly better predictions, but a single global model across dates using cane height combined with basal diameter is best practically. The results indicated that sugarcane N concentration can be determined by non-destructive means using dilution curves based on sampling of five sugarcane stalks once a month during the cane cycle. In order to determine the Ndff, only a single leaf from the cane plant needs to be harvested rather than the entire plant. These methods make it possible to study NUE by using mostly non-destructive techniques throughout the crop cycle.

Keywords: Nitrogen Use efficiency, Sugarcane, Non-destructive sampling procedure

Effect of different fertiliser application management strategies on leaching of nutrients and sugarcane yields on Negros Island, the Philippines

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Abstract

Groundwater is essential to residents as a water resource, especially on islands. Approximately 60% of sugarcane in the Philippines is produced on Negros Island. The concentration of nitrate-nitrogen in groundwater on Negros Island is relatively high, with fertilisers applied to sugarcane being the primary source of this nitrogen (N). Many famers apply a substantial amount of N during the initial growth stage of sugarcane, when the N-uptake ability of sugarcane is low.

To optimize fertiliser management, we conducted a field trial that included different fertiliser application strategies during the initial growth stage of newly planted sugarcane, and observed leaching of fertiliser using dielectric moisture and salinity sensors.

A randomized block design trial that included six N application treatments and four replicates was planted on 7 July 2016. As with the usual practice on Negros Island, the fertiliser treatments were applied as split applications according to the following schedule: T1 – recommended rate (87 kg N ha^{-1}) applied immediately after planting; T2 – recommended rate one month after planting; T3 – recommended rate two months after planting; T4 – half of the recommended rate applied one month after planting; T5 - zero N. In T1 to T5, 87 kg N ha^{-1} was applied as a second application three months after planting. T6 was zero N in both applications. Recommended rates of phosphorous (92 kg P_2O_5 ha^{-1}) and potassium (240 kg K_2O ha^{-1}) were applied to all plots. Dielectric moisture sensors (GS3, Meter Group, Inc.) were installed at 5 depths (5, 15, 25, 40, 60 cm from surface) in T1, T2, T4, and T6.

Soil solution concentration in T1 increased rapidly and substantially after fertiliser application. The fertiliser leached into deeper soil layers, and the soil solution concentration decreased to levels as low as before the first application one month before the second application. In contrast, soil solution concentration in T2 increased moderately compared to that in T1; however, concentration was maintained until the second application. In T4 and T6, concentration did not fluctuate substantially between applications. There was no significant difference in sugarcane yield or sugar content among treatments in the new planting.

Results indicate that immediate application of fertiliser after planting (T1) may lead to leaching of nutrients into the soil, and a shortage of nutrients before the second application. When nitrogen was applied at half the recommended rate or not at all (T4 and T5), sugarcane still maintained the same yield levels as plants that received the full recommended rate. Therefore, the recommended rate of nitrogen application (T1, T2, and T3) might be excessive during initial growth stage of sugarcane and could be reduce in new planting.

Keywords: sustainable fertiliser management, nitrogen fertiliser, dielectric moisture and salinity sensor

Developing soil-specific nutrient management guidelines for sugarcane grown on rejuvenating volcanic-alluvial soils in Nicaragua

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Abstract

Sugarcane is grown on about 33,000 ha on the San Antonio Sugar Estate and neighboring commercial farms in the Chinandega province in northwest Nicaragua. Nutrient inputs have traditionally been based on guidelines developed elsewhere. Modified nutrient management guidelines are being investigated to ensure sustainable sugarcane production into the future, and to ensure that nutrient inputs are based on locally-derived norms.

This poster reports on a series of replicated small plot nitrogen (N) x potassium (K) experiments that were established in 2014 to investigate the N, P and K requirement of sugarcane grown on a range of soil types typically derived from recent volcanic parent material and alluvial action. Soil samples were collected from the blocks of cane prior to trial establishment. Crop measurements were undertaken during the growing phase of each trial. The plant and first ratoon crops were harvested in 2015 and 2016 respectively.

Responses to applied N occurred at most of the trial sites. Agronomic and economic optimum N rates were calculated from the response data and corresponded to the rates of N at 95% of the maximum yield and the peak partial net return respectively. Although these values differed from each other, they provided a range of N rates for decision-making purposes, especially when viewed in combination with the calculated N-use efficiency (NUE) values calculated at tonnes cane/kg N applied. These locally-derived N rates are lower than the N rates previously used.

Although responses to applied K did not occur *per se*, the N x K interactions that occurred at some sites indicated that improved responses to applied N were possible when at least some K fertilizer was applied.

The results to date confirm that lower N rates than those traditionally used are applicable at San Antonio, and that attention needs to be paid to applying K fertilizer when required. This supports the concepts of sustainable and balanced nutrient management, applying appropriate N and K rates without compromising productivity or profitability.

Keywords: SIX EASY STEPS, nitrogen, phosphorus, potassium, volcanic soils

Soil spectral signatures for sugarcane fertiliser recommendations through an adapted soil typology

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Abstract

Sugarcane is a major pillar of Reunion Island's economy and covers 54% of arable land. In order to optimize yields, costs and sustainability, a soil-specific nutrient management expert system for volcanic soils, SERDAF, was developed in the 1990s, based on soil type and the chemical analyses of soil samples. Recent work, based on infrared spectral analyses combined with soil descriptions, have shown that some soil units of the soil map were misleading. This presentation will demonstrate how soil infrared spectral profiles can help to reclassify soil type and update the soil map.

Mid-infrared spectroscopy is a powerful tool for soil classification because it allows detailed mineralogical descriptions of soil samples. Different mineral and organic components absorb infrared radiation at different frequencies. The resulting absorption spectrum produces a characteristic shape that may be used for soil classification purposes. It will, therefore, be possible to redefine the Reunion soil map using a database of chemical analyses, made up of more than 45 000 samples collected from 1992 to present, and soil infrared spectral signature investigations.

Mining of the soil chemical analysis database showed marked variability in soil carbon (C) within some soil units, suggesting inconsistencies in soil type definitions and distributions. This, in turn, suggested that there is a need to revisit the soil map to improve fertiliser recommendations produced by the expert system. As nitrogen (N) and phosphorus (P) fertiliser requirements are highly sensitive to soil type, a more accurate definition of soil units will allow improved nutrient management guidelines. Laboratory experiments will provide updated values of the apparent utilization coefficient of N fertiliser applied as urea. Soil P-sorption capacities of soil units will also be adjusted.

The observed limitations of the current expert system suggested significant potential to improve the efficiency and relevance of fertiliser recommendations for sugarcane in Reunion. The impact of the planned revision on fertiliser recommendations will be investigated using sensitivity analyses.

Keywords: nutrient management, Reunion, soil, spectral signatures, sugarcane

Questioning the role of crop size in determining sugarcane nitrogen fertiliser requirements

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Abstract

Optimising nitrogen (N) fertiliser applications is an important topic in sugarcane production to improve both economic and environmental performance. In some countries, N fertiliser recommendations include a "yield term" to link cane N requirements (i.e. kg N per tonne of cane) to the N rate recommended. One pathway suggested to reducing N applications is to match the yield term to the yields achieved by farmers, as the latter are generally smaller than the former. This seems a sensible strategy: Smaller crops generally grown by farmers (relative to current yield targets) "should" need less N. Is it really that simple?

We collated over 200 N response curves for ratoon crops from past experiments in Australia, Brazil and South Africa to investigate the amount of N (N_{opt}) needed to achieve 95% of maximum sugarcane yield (Y_{95}).

There was little correlation between Y_{95} and N_{opt}. For example, low yields (e.g. <50 t/ha) occurred at both low (<50 kg/ha) and high (>200 kg/ha) N_{opt} values. The low correlation was also seen in individual experiments and thus the results were not an artefact of amalgamating data from different locations. At one experiment, for example, across five years the N requirement varied three-fold. Given that soil and management were consistent across the years, the variation showed the climatic influence on N requirement. The results also showed that there was variation between sites and crops in **both** yield potential and the amount of N required to grow a tonne of cane. Rather than trying to improve N recommendations by changing concepts around the yield term, we suggest it would be more beneficial to develop ways to predict N_{opt} directly. We simulated N responses with the APSIM model for one of the better characterised experiments in the database and derived N_{opt} from the response curves. Simulated N_{opt} was generally within the range of N_{opt} at the experiment.

We conclude that direct prediction of N_{opt} through application the APSIM model, in combination with seasonal climate forecasts could be the basis of a future decision support system to define optimum N rates.

Keywords: APSIM, climate, environmental nitrogen losses, simulation, yield goal.

Some early lessons from field trials using enhanced efficiency fertilisers

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Abstract

The SIX EASY STEPS program is recognised as the basis for best practice nutrient management in the Australian sugar industry. Although the SIX EASY STEPS N guidelines are generally appropriate, scope exists for fine-tuning of N application rates for specific circumstances. Nitrogen use efficiency (NUE) is useful for alerting growers/advisors to inefficiencies or circumstance where alternative N management options are worth considering. Enhanced efficiency fertilisers (EEFs), such as urea coated with 3,4-dimethylpyrazole phosphate (DMPP-coated urea) and polymer-coated urea, offer promise to improve NUE.

Two field trials were conducted to assess EEFs as alternatives to standard urea. The Bundaberg trial (sub-tropical semi-irrigated conditions) compared EEFs with various split applications of standard urea totalling 120 and 160 kg N/ha in a randomised complete block design with four replicates. The control received 40 kg N/ha in the plant crop and zero N in the first ratoon (1R). The trial was located on a red clay loam in a well-drained position. The Herbert trial (moist tropical conditions), laid out in a randomised complete block design with three replicates, aimed to establish yield response curves to EEFs versus standard urea (0, 60, 120, 160, 200 kg N/ha). The trial was located on a clay soil in a poorly drained position.

There were no significant yield responses to applied N, split applications or use of EEFs in the Bundaberg trial in either the plant or 1R crops. The rainfall measured during these particular seasons would not have resulted in excessively wet conditions at the trial site and may have contributed to the lack of responses to EEFs. Increased N-uptake by the crop, due to the use of N strategies away from the standard practice (i.e. by using EEFs or split applications of urea), improved NUE values based on crop N, but this did not always translate into any improvements in yield. The highest partial net returns in the plant and 1R crop corresponded to the control treatments. Urea applied at 120 kg N/ha in a single application resulted in the next best partial net returns in both crops. This appeared to be the most appropriate strategy to minimise risk to growers. The cost of EEF fertilisers negatively affected the partial net returns, with DMPP-coated urea being more affordable than the poly-coated urea.

No yield responses occurred to applied N in the plant crop in the Herbert trial. The 1R crop showed significant responses to applied N but no differences were apparent amongst the fertiliser formulations (EEFs versus standard urea). The lack of response to EEFs was possibly due to the seasonal rainfall pattern that did not favour marked N losses due to waterlogging or leaching. Despite reports from other projects of reduced N losses and potential maintenance of sugarcane yields when EEFs were used at lower N application rates, the results from this trial indicated that an N rate of 120 kg N/ha would have been appropriate irrespective of the N fertiliser formulation.

Further work, across seasons (dry, wet and 'normal'), is needed to evaluate more fully the potential of EEFs for use in specific circumstances.

Keywords: sugarcane, nitrogen, urea, enhanced efficiency fertilisers (EEFs), split applications

Variability of nitrogen use efficiency of urea in Réunion

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Abstract

In Reunion, sugarcane covers more than half of the cultivated area. Its production is highly dependent on the importation of mineral fertilisers such as nitrogen (N), a major driver for yield. Fertiliser materials from agro-industrial, urban and farming waste products (MAFOR) are locally available. Although these are important sources of nutrients, their fertiliser value, particularly N, remains unknown. The TERO project was launched in 2014 for this purpose. The behaviour of eight "MAFOR" products are being compared with urea (the most commonly used mineral fertiliser) via response curves.

TERO has implemented four trials in sites in high-contrast production areas - an altitude gradient of more than 500 m, average minimum temperatures between 15.6 and 20.8 °C and maximum temperatures between 22.7 and 28.7 °C, rainfall variation of 3,500 mm and soils with variable physico-chemical properties.

In each trial, the N requirements (X) were calculated from soil analysis results and based on the expected cane yield. Response curves were obtained from five treatments (0X, 0.5X, 0.75X, 0.9X, 1.5X) replicated three times. In the plant crop, half of the urea was buried at planting and the other half was spread on the soil surface four months later. Cane (including trash and tops) was harvested and weighed. The N content (N_{Dumas}) and N recovery was determined. Nitrogen use efficiency (NUE) values were calculated from the N response curves.

Data from three trials were available for this poster. Nitrogen response curves and NUE were very different from site to site. The trial conducted in the north of the island, on a Nitisol at an altitude of 50 m, resulted in a response curve that was sigmoidal, with an NUE of 0.35. The trial in the west, on a brown Dystric Cambrisol (Humic) at an altitude of 570 m, resulted in a response curve that was also sigmoidal, but with an NUE of only 0.12. In contrast, the trial conducted on the eastern side of the island, on an Haplic Umbrisols at an altitude of 330 m, resulted in a linear response between 0X and 0.9X. The calculated NUE was 0.92, highlighting better recovery of urea.

The variability in the responses to N, from one production area to another, justifies the diversity of trial sites in order to evaluate the NUE of the available MAFOR. The study will be conducted over two seven-year cane cycles to assess the direct and indirect effects of eight MAFOR products.

Keywords: sugarcane, MAFOR, nitrogen, response curves, NUE, Réunion Island.

Thursday 27 Sep 2018

Field Trip South

Time	Place	Subject	Presenter
07:30	Hotel Le Récif	Departure	-
07:30 - 08:30	-	Bus transfer	
08:30 – 10:00	Le Tampon ch. Ville Blanche	Harvest practices	Simon Duquesne
10:00 – 10:30	-	Bus transfer	-
10:30 – 12:00	Casernes (Saint-Pierre)	Logistic's Factory Casernes loading zone	Jean-Yves Gonthier Laurent Payet Philippe Rondeau
12:00 – 12:30	-	Bus transfer	-
12:30 – 14:00	Saint-Louis	Lunch	Camille Viot
14:00 - 14:30	-	Bus transfer	-
14:30 – 16:15	eRcane (L'Etang-Salé)	Project TraproH Mechanization Aérofaneur Heliosec BPE Phenology of weeds	V. Barbet-Massin Alizé Mansuy Daniel Marion
16:15		Return by bus	-
19:00		Gala Dinner	

Visit of a harvest site that uses mechanised harvesting:

Sugar cane harvesting on the Reunion Island is mainly a manual process, representing 65% of the total tonnage. The remainder is mechanised: 20% of the sugar cane is cut with a chopper harvester and 15% is harvested with "*coupeuses péi*" (mechanical cutting of long sugar cane). The constraints of the relief and stoniness of the terrain have limited the development of sugar cane chopper harvesting, a technique mainly used in low areas and on plots that have been levelled and cleared of stones. Manual cutting is hampered by the difficulties growers have in finding cutters, so mechanised harvesting may provide the best solution to this lack of manpower.

The mechanical harvester has a log cutting head that has been adapted to sugar cane, mounted on a 5- to 10-tonne mini digger. This tool has been developed locally, thanks to the innovative approach of the growers, and has been used since the beginning of the 2010s. Various models of cutting heads have been tested, fitted with shears or cutters, but the simple and double-bladed choppers have proved to be the most effective tools. An estimated 250 machines are currently used and this figure is constantly climbing, as the machine's effectiveness in harvesting on difficult terrain has been clearly demonstrated



Cutting heads : one blade (left) and double-bladed choppers (right)

The difficulties encountered by the growers who use the machine are primarily high-yield plots and/or entangled cane, and the cleaning of the sugar cane (topping and even removal the leaves). The increase in the proportion of impurities in the finished product as a result of this difficulty is detrimental for the sector: it reduces the richness of the grower's sugar cane (and consequently its purchase value) and generates additional costs for the manufacturer during the process, in particular the extraction phase.

The visit on 27/09/2018 will take place on the heights of Saint Pierre, with a grower whose plantation comprises twelve hectares of sugar cane, with little (if any) diversification. On average, he produces 1,300 tonnes per year, the equivalent of eleven tonnes per day. The relief on these plots means that he cannot use a chopper harvester, so the grower decided to invest in his own chopper in 2016.

The grower does not practise the mechanical removal of lower leaves using a rake, so he borrowed one from a neighbour during the visit. This additional phase takes place after the chopping, ridding the sugar cane of its trash, improving the richness of the load, and benefitting from all the advantages of leaving the mulch on the ground (limiting erosion, reinforcing the presence of organic matter, giving the grower greater control over weed control, etc.).

The loading phase is carried out using a turret loader, which resembles a Farmi, which is a logging loader. It is fitted to the tractor and its swivelling turret enables its gripper to rotate 360°. The adaptation of an existing tool is a real asset for loading sugar cane on difficult plots. With its extendable arms, which stabilise the tractor and its telescopic boom, the sugar cane can be loaded in a precise manner, even in difficult climatic conditions, and on plots whose relief makes it impossible to use a front loader or a Bell and even less so a cane loader. The loading rate of this kind of equipment is around fifteen to twenty tonnes/hour.

The Casernes loading zone

Following many years of successive industrial restructuring in the sector, certain closed sugar factories have been adapted to continue to ensure the reception of the sugar cane from local growers, and then transfer the sugar cane from the grower's trailer to trucks that transport them to the sugar mills. This has enabled the growers to limit the transportation distance (an average of 5 km on the island).

Hence, there are eleven loading zones located around the island's perimeter, and two loading zones in the two sugar factories. These zones take delivery of the growers' sugar cane between around 5:30 a.m. and 3 p.m. The transfer and transport by truck is generally carried out 24h/24. These loading zones also provide storage facilities.

Casernes is a loading zone located at Saint Pierre that supplies Le Gol sugar mill. It is the most important centre in the south of the island, with 250,000 tonnes delivered over 110 days in 2017, which is the equivalent of around 2,500 tonnes per day over a ten-hour period. The loading zone accepts the delivery of sugar cane produced by around 450 growers, who deliver the cane in agricultural trailers with an average ten-tonne payload.

At Casernes manually harvested sugar cane accounts for 77% of the delivered sugar cane, the chopped sugar cane 17%, and sugar cane removed mechanically with mechanical harvesters around 6%.

Each grower spreads their harvest throughout the harvest season (creating equity amongst growers in relation to the peak of richness and optimisation of their equipment). Hence, before the beginning of the marketing year, the sugar mill establishes a delivery schedule for each grower, which applies to the marketing year, in accordance with their projected tonnage.

When the sugar cane has been delivered and weighed, a sample is removed by the Interprofessional Centre for Cane and Sugar (a joint body, the Centre Technique Interprofessionnel de la Canne et du Sucre, CTICS) to determine the sucrose content ('richness') of the load, in order to calculate the price. The grower then drives his vehicle under the crane bridges, where he can unload his sugar cane depending on whether it is a chained bundle (lashed with chains) or it is fitted with a tipper trailer. The sugar cane is then stored for transportation at night, or directly transferred to a truck.

The sugar cane lorries (trucks with a twenty-four tonne payload) are driven under the feed hopper, which channels the sugar cane and prevents the grapple grabber from coming into contact with the sides of the trailer. During loading the weight is measured dynamically to avoid exceeding the maximum authorised weight (MAW). At the end of the loading process, the loaders use a tamper to ensure that the sugar cane does not project from the sides of the trailer. After driving away from the hopper, the driver of the sugar cane lorry checks the compliance of his load before heading to the factory.

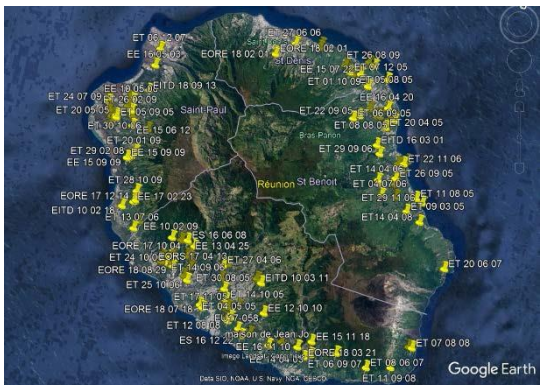
The growers who deliver the chopped sugar cane use a specific itinerary: after the sample has been removed, the tractor heads towards the chopped sugar cane table - a local specificity -, under which a sugar cane lorry is waiting. The grower unloads the sugar cane onto a conveyor belt that directly loads the sugar cane into the lorry. The average weight of a trailer fully loaded with chopped sugar cane is around twelve tonnes.

The Casernes loading zone has a reception quota of 2,400 tonnes/day, the equivalent of 230 grower weighings. The lorries transport 120 loads per day. It operates twenty-four hours per day, six days a week. The sugar cane delivered during the day is transferred to the mill within twenty-four hours.

eRcane Etang Salé Station : Project TraproH and Mechanization

The eRcane Etang Salé station was opened in 1987 for the selection of canes in order to meet the production conditions of irrigated cane crops. Recently, it has hosted two other projects:

- in 2012, the TraproH project, which conducts two types of trials: i) new herbicide registration trials, a program conducted jointly with Guadeloupe and Martinique; and ii) trials with registered herbicides that are combined to broaden the spectrum of efficacy of treatments offered to growers. We have a total of 10 active ingredients approved on cane. In addition to these activities, for the past two years, we have been conducting a trial with CIRAD on weed phenology;
- in 2014, has started the Mechanization project. This project supports two other eRcane projects, "Dephy expe" and "TERO", while developing its own program: mechanical straw management, minimum tillage and development of various tools which can evolve according to exchanges with farmers.



Herbicide testing sites since 2005



Heliosec



'Aérofaneur'



'Aérofaneur' with fertilisation

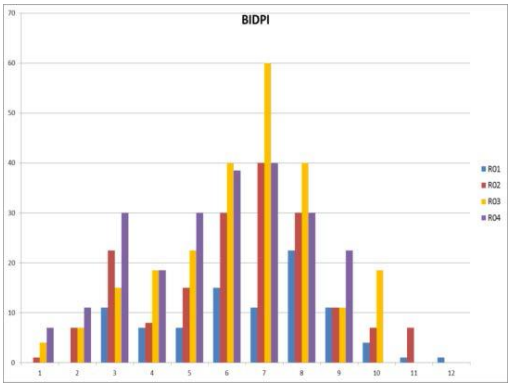
Phenology of weeds

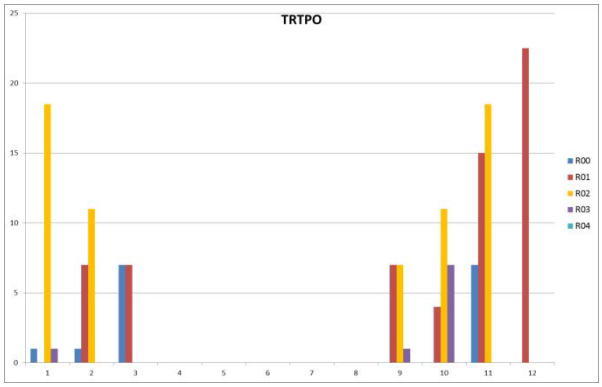
Characterisation of the phenology of the main weed species:

- dynamics of seasonal emergence
- duration of species development phases.

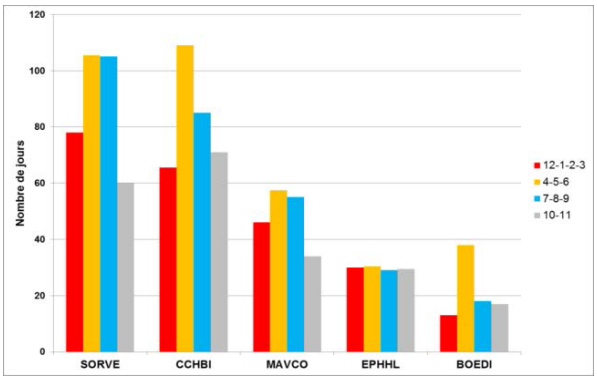


✓ In l'Etang-Salé (eRcane) – one year
✓ Every month: a new plot is plowed ➔ to start germination
✓ Observation of the phenological stage (emergence, emergence of leaves, flowering, fruiting) ➔ twice a week

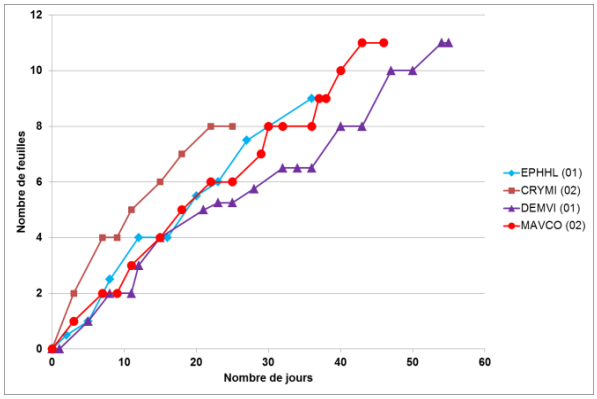




Cover (%) of *Bidens pilosa* and *Trianthema portulacastrum* / months



Delay for flowering



Number of leafs

Warm season species (*Trianthema portulacastrum*, *Boerhavia diffusa*) are clearly different from cool season species (*Bidens pilosa, Sonchus oleraceus*, *Argemone mexicana*).

Informations to manage methods of weed control

- ✓ avoid production of weed seeds
- ✓ reduce use of herbicides.

Friday 28 Sep 2018

Session	Chair	Time	Presenter	Presentation
Session 6 Irrigation and crop dynamics	Dr. Neil Lecler	**08:30 - 08:50**	Abraham Singels	Oral presentation 9
		08:50 - 09:10	Jean-Louis Chopart	Poster 32
			Daniel Marion	Poster 33
			Sanesh Ramburan	Poster 34
			Gislain Soubadou	Poster 35
		09:10 - 09:25	**POSTER VIEWING 6 + MORNING TEA**	
Group activity		**09:25 - 10:40**	**WORKING SESSIONS n°6 + demonstration**	
Facilitated report back, discussion and conclusion	Prof. Bernard Schroeder	**10:40 - 12:00**	**REPORT BACK / CONCLUSIONS**	
		12:00 - 12:10	Daniel Marion	Summation 1
		12:10 - 12:20	Neil Lecler	Summation 2
		12:20 - 12:30	Robert Gilbert	Summation 3
		12:30 - 12:45	As appropriate	Visual/oral presentation
		12:45 - 13:00	Bernard Schroeder	Close
		13:00 - 14:30	**LUNCH**	

Friday 28 Sep 2018

Session 6: Irrigation and crop dynamics

Chairman: Dr. Neil Lecler

Oral presentation		
Abraham Singels	9	A strategy analysis tool for supporting on-farm cane management during drought
Posters		
Jean-Louis Chopart	32	Estimating maximum available soil water depending on the sugarcane root systems for a deficit irrigation adjustment
Daniel Marion	33	Osiryl®, an efficient biostimulant for sugarcane
Sanesh Ramburan	34	Dynamics of sugarcane ratoon decline in southern Africa
Gislain Soubadou	35	Irrigation consulting tools for sugarcane

A strategy analysis tool for supporting on-farm cane management during drought

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Abstract

Drought is a frequent phenomenon in some sugarcane producing countries. Management of cane production during drought is difficult and requires reliable information on likely crop responses to implementation of strategic decisions. Here we demonstrate a program that predicts the impact of harvesting and irrigation strategies during drought on crop survival, productivity and profitability at field and farm level using two South African case studies.

The Microsoft® Excel program uses a daily crop and water balance model to calculate the crop status for each field of a defined farming unit, for a user-specified agronomic management strategy under assumed future climate and irrigation water allocation scenarios. Farm level gross margins (GM), for three consecutive years (Y1, Y2, Y3) are calculated from simulated yields and production costs at field level. Field inputs include field size, planting and harvest dates, variety, ratoon stage and soil type. Financial information includes costs of crop establishment, irrigation, harvest and transport, and the price of product (in South African Rands, ZAR). The user also specifies the expected category of future rainfall, and for irrigated farms, the expected future water allocation and a field specific irrigation strategy consisting of growth stage specific soil water thresholds (SWT) for triggering irrigations and survival priority.

The first case study comprised a hypothetical rainfed farm near Mount Edgecombe experiencing a two year drought (using weather data for the period April 2014 to December 2016). Results show that by delaying harvesting of four 'loss making' fields by four months (i.e. harvest at 16 months instead of 12 months), increased farm average GM in Y1 and Y2 by ZAR 3 000 and 2000 per hectare, respectively).

The second case study comprised a hypothetical irrigated farm near Komatipoort, subjected to two restricted water allocation scenarios (50 and 25% of the norm) during a two year drought (also using weather data for the period April 2014 to December 2016). Results showed that using SWT of 30 and 60% of plant available water capacity during the tillering and stalk growth phases, respectively, produced the best farm average yield and GM for both scenarios. Although SWT of 20% enabled the survival of more fields, it led to substantial reductions in yield and GM in Y1 and Y2. Withholding irrigation (abandoning) on fields that were due to die, increased farm GM in Y2.

Results from this preliminary study suggest that cane yield and GM predictions from the program are realistic, and that it has the potential to aid strategic crop production decision-making during drought to minimize its negative impacts. Further evaluations under diverse scenarios are recommended.

Keywords: drought, irrigation, harvesting, strategy, gross margin, cane yield, crop model, water allocation

Estimating maximum available soil water depending on the sugarcane root system for a deficit irrigation adjustment

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Abstract

We present the findings of a study testing the PRER (Potential Root Extraction Ratio) model (Leifi *et al.*, 2011) to estimate the maximum available soil water (MASW) depending on the sugarcane root system in a deep soil of La Reunion. The aim is to optimize sugarcane irrigation, especially deficit irrigation (DI), by adjusting irrigation rates and intervals according to root distribution in the soil.

The experiment was conducted in a deep Cambisol in La Reunion. Sugarcane cultivar was R570. Measurements where done in a ratoon crop nine months after harvest of the previous crop. Root spatial distribution was studied using the trench-profile method by counting and mapping root intersections (RI) in four soil profiles to a depth of four metres using a grid with a 5 x 5 cm mesh. From RI, we inferred root length densities (RLD) (Chopart *et al*., 2008) and root distances (RD) (Newman, 1969).The PRER (%) is the ratio of volume of soil potentially accessible to a root for water uptake (Vu) and the whole volume of soil assigned to that root (Vt). Modelling of Vu took RD into account as well as a maximum distance of water movement from soil to roots (5 cm). The conventional maximum available soil water (MASWlab) was measured at several depths. It had a uniform value of 0.1cm/cm from the soil surface to the four metre depth.

The results revealed a wide variability in root distribution between the soil surface and the rooting front (4 m), with many competing roots and rootless zones. PRER values ranged from 80% near the surface to values ranging from 30% to 1% between the 1 – 3 m depth. From PRER and MASWlab, we estimated a biological MASW (MASWbiol) depending on root distribution in the soil. MASWbiol ranged from 0.8 mm/cm near the surface to 0.4 mm/cm at 1 m, and 0.01 mm/cm at 3 m. Total MASWbiol was 86 mm (stand. dev.: 14) and 88 mm for the 3 and 4 m rooting depths respectively. When only rooting depth and MASWlab/cm were used, values of total MASWlab ranged from 300 mm to 400 mm for the 3 – 4 m depth interval.

There was a marked difference between conventional MASWlab and MASWbiol calculated from root mapping and PRER modelling. MASWbiol appeared to provide a better estimate than conventional MASWlab for crop modelling and irrigation, especially for DI. Importantly, DI requires a good estimate of how long it takes the soil water storage to be depleted to the maximum allowable value.

Results showed the need to consider rooting depth and root spatial distribution in deep sugarcane-producing soils of La Reunion. This could also be applicable in places like Brazil, where sugarcane rooting depth may reach 4 m (Chopart *et al*, 2010) or beyond (Laclau and Laclau, 2009), or for soils with physical constraints where root distribution is very irregular.

Keywords: rooting spatial distribution, root length density, potential root extraction ratio

Osiryl®, an efficient biostimulant for sugarcane

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Abstract

Benefiting from optimum production resources like water and nutrients is crucial in sustainable agriculture, both from environmental and economical perspectives. In Reunion, where arable lands are pressured by insularity and an increasing population, ensuring a sufficient supply of sugarcane for the two mills depends markedly on an increase in productivity.

Osiryl®, a biostimulant which promotes root growth by slowing down auxin degradation, was evaluated in two field trials in a strip plot design with three replicates. Three rates of biostimulant, 10, 15 and 20L/ha, were sprayed at the base of ratooning cane, targeting both cane foliage and trash blanket. Ratoons were sprayed two to three month after harvest and over two consecutive years. Treatments were compared to a control without Osiryl®, which reflected grower's normal practice. Mineral fertiliser applied was identical on all plots.

The 2-year average yield for both trials showed that Osiryl ® had no impact on the CCS and that the three treatments with the biostimulant were more productive than the untreated control, both in cane and sugar yield. Differences were statistically significant for rates of 15 and 20 l/ha ($p < 0.0001$) with respectively + 10.2 and 18.0 t cane/ha and + 2.0 and + 2.7 t sugar/ha (GML in Minitab). The average yield of the untreated control was 94.1 t cane/ha, equivalent to 13.8 t sugar/ha.

Keywords: sugarcane, biostimulant, yield, sustainability

The dynamics of sugarcane ratoon decline in southern Africa

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Abstract

Ratoon decline (RD) is a common feature of sugarcane cropping systems worldwide, and is a key economic consideration in decision-making on replanting. Historically, longer ratoon cycles (>9 crops) were thought appropriate for maximising profitability in southern Africa. However, recent developments have prompted a re-evaluation of the economic viability of long ratoon cycles. As a starting point for this assessment, commercial production data from various sugarcane estates in southern Africa were interrogated to: i) compare RD trends between broad regional cropping systems; ii) identify key factors affecting RD; and iii) explore likely economic impacts of varying ratoon longevity within cropping systems.

Ten independent datasets from irrigated and rainfed estates in South Africa, Tanzania, Zambia and Mozambique were analysed. Mean cane yields and sucrose % were calculated per crop class (ratoon) averaged over all available production years. Where available, effects of factors such as irrigation system, variety and time of harvest (early vs. late) were examined for differential RD trends. Using the production data from each estate, the accumulated profitability of a conventional long (plant + 9 ratoons) ratoon cycle was compared to that of two short (plant + 4 ratoons) ratoon cycles in a 10-year period.

All datasets indicated that quadratic relationships existed between cane yield RD and ratoon number, with R^2 values ranging from 0.54 to 0.96. In most cases, stabilisation of yields occurred around the 3rd ratoon crop. Differences in RD between irrigation systems were evident on some estates, but not consistent across estates. Except for one irrigated estate, varietal effects on RD were generally negligible. Late season harvesting, in general, exhibited sharper RD rates than early harvesting, particularly under irrigated conditions. In high potential irrigated systems (cane yield >100 tonnes/ha) with slow rates of RD, the longer ratoon cycle (plant + 9 ratoons) was generally more profitable than the shorter. With faster RD rates, the shorter ratoon cycle (plant + 4 ratoons) became more profitable. In low potential rainfed conditions, the shorter cycle was only marginally better than the longer cycle. However, in both water regimes, when the practicalities of implementing a shorter cycle were considered (inclusion of additional fallow and/or reducing harvest age to replant within the same season), this strategy became less economical than the longer cycle. The profitability of the shorter ratooning cycle was inversely related to the rate of RD.

Efforts to minimise crop turn-around time (plough-out to replant) or sustain cash flow with break crops may be alternatives to improve profitability of the shorter ratooning strategy. Exceptions to the general findings are presented and practicalities discussed to illustrate the dynamics of decisions relating to ratoon cycle.

This analysis has revealed strong dependencies of profitability on the overall RD rate and suggests that site-specific decisions, aided by a decision support system, would be most appropriate.

Keywords: ratooning ability, ratoon decline, replant

Irrigation consulting tools for sugar cane

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Abstract

Irrigation is experiencing a gradual evolution in Reunion as reflected in the development of large area such as the *Bras de la Plaine*, the *Bras de Cilaos*, *Champ Borne* and the West Coast. These areas, located at altitudes between 0 and 660 m above mean sea level, are mainly used for sugarcane production, the most common crop in the agricultural landscape. Water requirements vary greatly according to geographical area, altitude and the crop cycle. Finding the balance between the different uses of water, particularly in relation to availability, remains a major challenge for economic development.

The Chamber of Agriculture identified the need to provide farmers with decision-making tools to optimize the management of irrigation on-farm, contribute to preservation of the water resources and improve sugar cane production

The following irrigation tools are available:

- *Irrigation disc* – Users have access to specific discs for each of the 18 homogeneous climatic zones in the irrigated areas on Reunion Island. Once reset at harvest, the appropriate disc will indicate the volume of water (m^3/ha) needed to restore the soil water reserve to field capacity at the beginning of the crop cycle. The disc will also display irrigation application rates (m^3/day/ha) in the absence of rain or the period when no irrigation is needed if rain has occurred.
- OGICAS Irrigation Software– This user-friendly application is accessible via the Chamber of Agriculture website. It provides information relating to irrigation management for the various agricultural sectors, including location and appropriate parameters. It automatically calculates the irrigation needs and application rates as with the irrigation discs, but the advice is customized. It also provides a report for the grower's use and records.

Keywords: irrigation, tools to aid decisions, sugarcane

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