Projects and strategies to introduce a synergetic controlled-traffic farming system to Zimbabwe

N Lecler

Zimbabwe Sugar Association Experiment Station, Private Bag 7006, Chiredzi, Zimbabwe; and School of Engineering, University of KwaZulu-Natal, P/Bag X01, Scottsville, 3209, South Africa; nlecler@zsaes.zw

Abstract  Pilot projects to introduce a new controlled-traffic farming system (CTFS) to the Zimbabwean Sugarcane Industry were initiated in 2011. The CTFS is founded on a synthesis of scientific principles and research reported in the worldwide literature. The development and practical implementation of the CTFS for both overhead- and surface-irrigated sugarcane in Zimbabwe is described and discussed. The CTFS was designed to address many of the challenges faced by the sugarcane industry, including: compaction, stool damage and a general reduction in the productive capacity of soils, pest and disease control, declining crop yields and profitability, water and energy supply constraints, and performance of relatively high sucrose content varieties. The question of whether the CTFS has the expected benefits comes down to whether the scientific studies and engineering principles that underpin it are valid and could they be implemented in practice, in a commercial environment, without undue compromise? For sprinkler irrigation systems these questions have been largely answered in the affirmative, as evidenced by the relatively high sugar yields attained in a commercial environment. New varieties grown in the pilot project had relatively high estimated recoverable crystal (ERC) contents and yields of ERC averaged 18.6 t/ha for the three plant, two first-ratoon and one second-ratoon crops harvested to date, on approximately 300 ha. Other benefits included an increase in payload of approximately 6%. The main advantages of the new surface irrigation system are that it permits relatively efficient energy and water usage; it is simple to operate and maintain, and it allows users to capitalise on the synergistic benefits of the CTFS. At the demonstration site, ERC yields for the plant crop were 19 t/ha using only 7 ML/ha of irrigation water. Typically, better performing plant-cane fields in the industry yield approximately 15 t ERC/ha and can use 13-19 ML/ha of irrigation water. The widespread adoption of the CTFS is recommended. Representative associations could develop and offer appropriate ‘Farming System Services (FSS)’ whereby they would procure the necessary equipment and expertise and provide CTFS services to both large (estate) and small growers on a cost-recovery basis.

Key words  Controlled traffic, farming system, surface irrigation

INTRODUCTION

At the 2010 annual congress of the South African Sugar Technologists’ Association, Lecler and Tweddle (2010) presented a paper titled “Double profits with a controlled traffic zero-till farming system?”. Following research results and rationale reported by, amongst others, Garside et al. (2001) in Australia, Meyer and van Antwerpen (2001) in South Africa, Nixon and Simmonds (2004) in Swaziland and Umrit et al. (2009) in Mauritius, all of whom highlighted the benefits of a break crop and the negatives of cane monoculture, they proposed a controlled-traffic farming system (CTFS) and showed in a rigorous but theoretical analysis that it was far more profitable than conventional sugarcane farming systems.

The CTFS aimed to alleviate compaction damage and the associated need for heavy tillage; therefore, allowing more frequent, lower cost re-planting and relatively frequent rotation crops. By alleviating compaction damage and including more frequent rotation crops, soil conditions should improve and this should help sustain higher sugarcane yields. Furthermore, pests and diseases, including smut, ratoon stunting disease, nematodes, and ehdana borer, and weeds, should pose far less problems if re-planting is done more frequently, especially after growing a rotation crop and breaking the monoculture. In their analysis, Lecler and Tweddle (2010) showed that, in theory, the CTFS also yielded substantial gains in water-use productivity, i.e. the sugar produced for a given amount of water.

In an effort to turn theory into practice, pilot projects to develop and introduce a new CTFS to the Zimbabwean Sugarcane Industry were initiated in 2011 with funding support from the European Union and following justification to industry principals. The CTFS involves:

- a new harvesting and re-planting schedule that ensures rateable delivery of relatively mature and high sucrose content cane;
a relatively frequent rotation crop to help maintain soil health and reduce pest and disease pressure;

a 2.4 m x 0.9 m tramline row-spacing arrangement and new harvesting system that permit controlled trafficking, minimal compaction damage, excellent agronomic performance and relatively high in-field machine operating efficiencies;

tractors fitted with GPS/GLONASS auto-steer and modified 2.4 m wheel tracks to fit with the row spacing and help minimise compaction damage; and

new and prototype implements to facilitate relatively inexpensive, minimum-tillage re-planting and the incorporation of a break or rotation crop.

Around 500 ha have been successfully planted to the new CTFS under sprinkler irrigation. The majority of the area was planted to new relatively high-sucrose varieties selected in the breeding program at the Zimbabwe Sugar Association Experiment Station (ZSAES). In a companion project, a novel surface-irrigation system, named synergetic surface irrigation (SSI), has been developed to allow use of the CTFS with surface irrigation. The operations used and results obtained for both overhead and surface irrigation are described and discussed in this paper.

SYNERGIES IN THE CTFS

The essential synergies of the CTFS are summarised in Figure 1.

An important aspect of the CTFS is the replanting and harvest schedule. The schedule allows for planned replanting after only three ratoon crops (Fig. 2). Cane is harvested at 14 months of age when it is mature and has relatively high sucrose contents. At the same time, the schedule ensures a consistent and rateable supply of cane to the mill during the milling season, i.e. typically the months of March to November in Zimbabwe. An alternative option is to harvest at 13 months of age and harvest seven ratoon crops before the rotation crop. However, in their analysis, Lecler and Tweddle (2010) showed that having only three ratoon crops was more profitable than having seven ratoon crops, even when there is only a 3% per year decline in the yields of ratoon crops. Furthermore, having fewer ratoon crops and more frequent rotation crops helps to improve soil health and ensures most traditional pest and disease challenges are minimised – these are very important benefits of the CTFS.

Fig. 1. Controlled Traffic Farming System: ‘Synergy Chain’. The near doubling of profits was reported in a theoretical analysis by Lecler and Tweddle (2010).
CTFS OPERATIONS

Some of the main objectives of the pilot projects were to develop, test and refine the procedures and implements required for the practical implementation of the CTFS in a commercial environment.

Process to alleviate compaction from the traditional farming system in order to convert to the CTFS

Ideally, a field being converted to the CTFS should be harvested towards the end of the milling season, typically around November in Zimbabwe. This permits the rotation crop to be direct-drilled in October-December (Fig. 2). The recommended operations for the conversion to a CTFS are to direct-drill a legume rotation crop into knee-high cane that has been sprayed with an appropriate herbicide to kill it. Once the rotation crop has grown, for example, if the rotation crop is sunn hemp (*Crotalaria juncea*), after approximately 70 days, a chisel ripper with a roller attachment can be used to knock-over the standing rotation crop and chisel-rip directly under where the new cane will be planted. The action of the chisel ripper is to lift and loosen a large volume of soil per tine. As a result, it does an excellent job of alleviating antecedent compaction, can be used effectively over a wider range of soil moisture conditions compared to traditional rippers that need relatively dry soils and rely on a shattering affect, and it has relatively low draft requirements due to the lifting action. Use of GPS/GLONASS auto-steer on the tractor enables the chisel ripping to be done exactly where the new cane will subsequently be planted in the 2.4 m x 0.9 m dual row-spacing arrangement. This targeted alleviation of compaction where only some areas of the field are chisel ripped, allows relatively wide implement widths and high field operating efficiencies. Alternatively and to help facilitate mechanical planting, the standing break crop can be ‘mulched’ with a mulch mower.

In the pilot projects sunn hemp has proved to be a hardy and a relatively simple rotation crop to grow, yielding close to 4.6 t/ha dry matter with a nitrogen content of 2.44%. An alternative rotation crop that may have very important cash-flow advantages during the conversion process is soybean. However, growing a soybean rotation crop requires more effort and attention than sunn hemp and, if the beans are to be harvested and sold, it requires a much longer growing period, i.e. > 130 days compared to about 70 days. A ‘direct drill’ John Deere 1590 planter was a good match with the CTFS row spacing arrangement. In the CTFS system it has an effective working width of 4.8 m and was selected for drilling either sunn hemp or soybean. It has worked effectively in both zero-till and tilled conditions.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>ETC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>P1</td>
<td>P2</td>
<td>P3</td>
<td>P4</td>
<td>P5</td>
<td>P1</td>
<td>P2</td>
<td>P3</td>
<td>P4</td>
<td>P5</td>
<td>P1</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td></td>
</tr>
<tr>
<td>Jul</td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td>C2A</td>
<td>C3A</td>
<td>C4A</td>
<td>C5A</td>
<td>C1A</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td>C2B</td>
<td>C3B</td>
<td>C4B</td>
<td>C5B</td>
<td>C1B</td>
<td></td>
</tr>
</tbody>
</table>

Key

SO/D1 - spray out and drill break crop on Field 1
P1 - plant cane on Field 1
C1A - cut cane on Field 1, portion A (50%)
C1B - cut cane on Field 1, portion B (50%)

Fig. 2. Harvest and re-planting schedule designed for the Controlled Traffic Farming System.
Planting sugarcane

The long-term plan has been to use a mechanical double-disc zero-till cane or speedling planter for planting cane in the 2.4 m x 0.9 m tramline arrangement, as shown in Figure 3. Preliminary analyses show that use of a prototype double-disc mechanical planter has the potential to halve the costs of planting by hand due mainly to a reduction in seed-cane and labour (Lecler 2013). However, development of a suitable custom-built planter is still ongoing. Although the prototype mechanical planter performed adequately when planting into recently tilled soils, mechanisms that will work adequately when planting into knocked-over or mulched sunn hemp (or soybean) under zero-till conditions are still being developed. The main challenge is ensuring adequate coverage of the cane setts under these conditions. Currently, a modified covering mechanism for the planter had been fitted but not yet field tested.

In the interim, cane has been planted by hand after opening planting furrows with a specially configured re-ridger that has an effective working width of 4.8 m. Use of GPS guidance allowed relatively high tractor and driver productivities and extremely accurate layouts. It also enabled the chiselling (soil loosening) to happen directly under where the cane was subsequently planted which was ideal. Germination and early growth in all CTFS blocks was outstanding.

Harvesting sugarcane

Harvesting in the CTFS required cutters to adapt to a new system whereby seven lines of cane, i.e. 3.5 tramlines were windrowed into one line to facilitate mechanical loading. This system enabled the haul-outs to travel on one lane for every 14 lines of cane and the mechanical loader to travel on one lane for every seven lines of cane, i.e. the loader loads a windrow of cane on both sides of the haul-out lane. The row spacing is such that the wheels of the loaders and the haul-outs do not travel directly over the cane rows or stools.

Synergetic Surface Irrigation

To facilitate using the CTFS with surface irrigation, a novel irrigation system is being developed in a companion project. The system, named Synergetic Surface Irrigation (SSI), allows small amounts of water (about 20 mm per application) to be applied at relatively high uniformities (low quarter distribution uniformity > 80 %) with minimal losses, thus facilitating efficient and effective irrigation on a wide range of soils (Lecler 2015).
Even though the irrigation furrows are relatively short, which is what permits the relatively robust and effective irrigation performance; the layouts permit long rows (field lengths) and are designed to suit the CTFS and leverage on associated benefits and synergies. The concept of irrigating long fields with short furrows is illustrated in Figure 4.

![Diagram of irrigation system](image)

**Fig. 4.** Schematic showing how long fields are irrigated by sequencing the flow of water to in-field laterals and short furrows. Laterals can be made of polyvinyl lay-flat and rolled up to permit trafficking or they can be buried.

To fit with the CTFS the cane row and furrow spacing arrangement was selected whereby dual rows of cane spaced about 0.9 m apart are planted with 2.4 m between the centres of each pair of dual rows. A relatively small irrigation furrow is located between the dual rows (refer to Fig. 5).

**Farming operations used at the SSI demonstration site**

At the SSI demonstration site, planting was done by opening furrows for the cane setts with a ducks-foot ridger, laying cane setts by hand and then a prototype ‘bed-and-furrow forming’ implement was used to simultaneously open and smooth the irrigation furrow, form a bed and cover the cane setts (Fig. 5).

After harvesting the plant crop the plan was to prematurely kill the cane in order to test equipment and procedures for incorporating a rotation crop and re-establishing a cane crop. The cane was killed effectively by spraying it with glyphosate. Sunn hemp was then drilled directly into the dying cane stools using the direct drill seeder. This worked well and germination and growth of the sunn hemp crop was good.

Using the prototype double-disc cane planter to plant into the knocked-over sunn hemp crop was not successful and modifications to procedures and implements to address the challenges encountered have been developed but currently had not yet been field tested.

When re-planting an alternative but less desirable procedure would be to disk the break crop and open planting furrows with a ridger and then use the bed-and-furrow former to cover the cane setts and form an irrigation furrow as was done when the initial crop was planted.
RESULTS

The question of whether the CTFS ‘works’ or has the expected benefits comes down to whether the scientific studies and engineering principles that underpin it are valid and could a system be designed to synthesise and implement the principles and science in practice, in a commercial environment, in Zimbabwe, without undue compromise, for sprinkler and furrow irrigation.

Sprinkler irrigation

For sprinkler irrigation systems (potentially including pivots), these questions have been answered in the affirmative, as evidenced by the relatively high sucrose yields attained in a commercial environment in the pilot project, amongst other things. Based on Direct Analysis of Cane (DAC) results from the ZSAES laboratory, the estimated recoverable crystal (ERC) yields for the six crops harvested to date in the pilot project averaged 18.6 t/ha. Typically, commercial yields of ERC on the estate are close to 12 t/ha. The relatively high yields in the pilot project were maintained into the ratoon crops, indicative of reduced compaction damage amongst other things. Many other important benefits were noted. For example, apart from minimising compaction damage, the harvesting system and layout resulted in more effective mechanical loading, i.e. an approximately 6% increase in average payloads and an associated reduction in haulage costs – a major cost component in a sugarcane business.

Furrow irrigation

For furrow irrigation there has been good progress at a relatively small demonstration site where the novel ‘short furrow/long field’ SSI system has been implemented in a complimentary project. The main advantages of the new surface irrigation system are: it permits relatively efficient energy and water usage (Fig. 6); it is simple to operate and maintain; and it allows users to capitalise on the synergistic benefits of the CTFS. The relative low energy requirement is mainly because the pressure requirement at the field edge is only 15 kPa (compared to around 350 kPa for typical sprinkler systems). At the SSI demonstration site, ERC yields for the plant crop were 19 t/ha using only 7 ML of irrigation water per hectare. Even though this result was achieved under ‘Research Station’ conditions at a small demonstration site, it is a remarkable result when it is considered that, typically, better performing plant-cane fields in the industry yield approximately 15 t ERC/ha and can use 13-19 ML of irrigation water per hectare (Lecler and Griffiths 2003), i.e. with SSI, higher yields were achieved using less than half the amount of irrigation water.
**Fig. 6.** Relative energy requirements of synergetic surface irrigation. Note, for long furrow, no pumping is assumed, i.e. it was assumed the fields are gravity fed, which is often but not always the case in Zimbabwe.

**DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS**

Overall, the yield results in the large scale sprinkler irrigated CTFS pilot project have been sustained at relatively high levels under typical commercial conditions with all the associated constraints, especially with regard to power and water availability. DAC results for new varieties grown in the pilot project that were analysed in the ZSAES laboratory have shown relatively high ERC contents. This is beneficial to the harvesting, haulage and milling operations.

The 2.4 m x 0.9 m tramline planting arrangement was selected because it allows for relatively high machine operating efficiencies, minimal compaction and is good from an agronomic perspective. In particular, it suits the potential introduction of dual-row chopper harvesters with 2.4 m wheel-tracks, for example the John Deere 3522 and in the interim it suits the wheel-tracks of the mechanical loaders that are used on the estate that is hosting the pilot project. Chopper harvesters with wider wheel-tracks do less compaction damage when compared to chopper harvesters with 1.8 m wheel-tracks and also operate at higher field efficiencies, needing to travel and turn 25% less for every hectare harvested.

Hand cutting CTFS blocks was successful. Cutters adapted well to the new layouts. With the mechanical loaders, heavy traffic and associated compaction was limited to a very small proportion of the field with no 'on-the-cane-stool' traffic. Pay-loads were relatively high because the distance between the loader and the haul-outs was such that the loader dropped bundles of cane ‘perfectly’ parallel to the direction of travel of the trailers, due to the row spacing. This resulted in denser loads. The relatively large windrows contributed to high loading efficiencies.

In addition to potentially solving the problems of inefficient irrigation, particularly but not only with traditional ‘long’ furrow irrigation, a major advantage of the new SSI system is that the layouts permit efficient mechanical operations, including mechanised harvesting, should this be desired. The introduction of chopper harvesters will be a problem with conventional farming systems and the 1.5 m row spacing lay-outs traditionally used in Zimbabwe; particularly with furrow irrigation where cane is typically planted in the furrow and irrigation water is siphoned into furrows from concrete lined ‘feeder’ canals. The CTFS and SSI have been designed with chopper harvesters in mind and should permit a relatively easy transition. In the interim they permit efficient use of mechanical loaders and large in-field haulers with minimal compaction damage, no damage to, or hindrance from, concrete feeder canals and relatively high output from cane-cutters who ‘cut and windrow’ rather than having to ‘cut and stack’ cane.

There was consensus amongst the team from the collaborating estate who are hosting the large scale CTFS pilot project under sprinkler irrigation, that the CTFS: can be implemented in practice, has many advantages relative to the traditional farming system and has no major risks. Having only three ratoon crops is still a mind-shift for many people to make and has required many presentations to justify. Although the original plan was to plant using the mechanical double-disc cane planter, an alternative system to facilitate planting by hand was developed and is being used successfully in the interim.
WHERE TO NOW?

Taking into consideration the underlying science and rationale and the very positive results realised in the pilot projects, it is recommended that a strategy to ‘roll-out’ the CTFS and SSI be developed in order for both large- and small-scale growers to capitalise on the benefits of the systems. Growers, especially small growers, may not have the necessary finance and/or be able to afford self-owning specialist equipment that will be under-utilised on their small areas. Large growers/estates could plan to replace and downscale existing machinery fleets with appropriate equipment and would benefit from economies of scale, improved operating efficiencies and a reduction in ‘per-hectare’ machine costs. Converting inefficient and/or energy intensive irrigation systems to SSI should result in substantial benefits.

Using established machinery contractors may be challenging. Initially they may not have the necessary expertise and will need to invest in new and specialised equipment. This may carry excessive financial risks and be cumbersome. Co-ordination will be difficult and the relationship between contractors and growers, especially small growers is often fraught with challenges. Millers could initiate a ‘Farming System Service’, however, there are often miller/grower conflicts that may hamper this option.

An alternative proposal, which appears to have many advantages, including administrative, is for well-established but representative associations such as the Zimbabwe Sugar Association (ZSA) to develop and offer appropriate ‘Farming System Services (FSS)’ whereby they would procure the necessary equipment and expertise and provide CTFS services to both large (estate) and small growers on a cost-recovery basis, i.e. initiate a ZSA FSS. CTFS operations could be done at highly competitive rates due to economies of scale in terms of utilising equipment and human capital/expertise from a central pool. An analogy can be drawn with soil testing services where organisations such as the ZSAES have purchased sophisticated laboratory equipment and employed specialist personnel to undertake soil analyses to the benefit of the wider industry.

Facilitating the widespread adoption of the CTFS and SSI is an opportunity to make a radical improvement to increasing and sustaining profits in the Zimbabwean (and southern African) irrigated sugarcane industry. While much focus has been on the benefits to growers, widespread adoption should result in the mills being supplied with relatively mature (14 month old) and high sucrose content cane. This will reduce ‘cane-to-sugar’ ratios and be of great benefit to the profitability of the mills.

REFERENCES

Lecler NL. 2013. A prototype zero-till cane planter for controlled traffic farming. Presentation given at the 2013 Annual Field Day of the Zimbabwe Sugar Association Experiment Station, Chiredzi, Zimbabwe.

Des projets et des stratégies pour introduire un trafic contrôlé synergetterique en exploitation agricole au Zimbabwe

Résumé. Des projets pilote pour introduire un nouveau trafic contrôlé en exploitation agricole (CTFS) dans l’industrie sucrière zimbabwéenne ont été initiés en 2011. Le CTFS est fondé sur une synthèse de principes scientifiques et de recherche cités dans la littérature internationale. Au Zimbabwe, le développement et la mise en œuvre pratique du CTFS pour l’irrigation de la canne à sucre tant par aspersion que de surface sont décrits et commentés. Le CTFS a été conçu pour répondre à des challenges auxquels doit faire face l’industrie sucrière : la compaction, les dommages occasionnés par les outils, la baisse générale de la capacité de production des sols, la
maîtrise des parasites et des maladies, le déclin des rendements de la culture et des profits, les contraintes d’approvisionnement en eau et en énergie et la performance des variétés à teneur en sucre relativement élevée. La question est de savoir si le CTFS présente les avantages auxquels ont peut s’attendre, c’est-à-dire, est-ce que les études scientifiques et les principes d’ingénierie qui le soutiennent sont valides et ce système peut-il être mis en œuvre en production commerciale sans compromis excessif ? Pour les systèmes d’irrigation par aspersion il a été largement répondu par l’affirmative à ces questionnements, comme le témoigne les rendements relativement élevés obtenus en production commerciale. Les nouvelles variétés cultivées dans le projet pilote ont un sucre estimé récupérable (ERC) relativement haut et des rendements en ERC en moyenne de 18,6 t/ha pour trois plantations, deux premières repousses et une deuxième repousse récoltées à ce jour approximativement sur 300 ha. Un autre avantage était une augmentation du chargement d’environ 6 %. Les principaux avantages du nouveau système d’irrigation de surface sont qu’il facilite un usage relativement efficient de l’énergie et de l’eau ; il est simple à exploiter, à entretenir, et permet aux usagers de tirer profit des avantages synergie des CTFS. Sur le site de démonstration, les rendements ERC pour la plantation ont été de 19 t/ha pour seulement 7 ML/ha d’eau d’irrigation. Classiquement, les meilleurs rendements obtenus en plantation industrielle sont approximativement de 15 t/ha de sucre estimé récupérable (ERC) pour un volume d’eau d’irrigation de 13 à 19 ML. La généralisation du développement du trafic contrôlé (CTFS) est recommandée. Des opérateurs pourraient développer et offrir les services appropriés (FSS) pour lesquels ils fourniraient équipement et expertise nécessaires en apportant les services du trafic contrôlé (CTFS) aussi bien aux grandes exploitations qu’aux petits fermiers avec un coût d’intervention donné.

**Mots-clés:** Trafic contrôlé, système d’exploitation, irrigation de surface

### Proyectos y estrategias para introducir a Zimbabwe un sistema agrícola sinérgico de tráfico controlado

**Resumen.** Proyectos piloto para introducir un nuevo sistema agrícola de tráfico controlado (SATC) a la industria de caña de azúcar de Zimbabwe se iniciaron en el año 2011. El SATC se basa en una síntesis de principios científicos e investigación publicada en literatura de todo el mundo. El desarrollo y la aplicación práctica del SATC tanto para caña de azúcar con riego por aspersión e irrigado por gravedad en Zimbabwe se describen y comentan. El SATC se diseñó para abordar muchos de los desafíos que enfrenta la industria de la caña de azúcar, incluyendo: compactación, daños a la cepa y una reducción general de la capacidad productiva de los suelos, control de plagas y enfermedades, disminución de rendimientos de cultivos y rentabilidad, restricciones en el suministro de agua y energía, y el rendimiento de variedades con contenidos de sacarosa relativamente altos. La pregunta de si el SATC tiene los beneficios que se espera se reduce a si los estudios científicos y principios de ingeniería que lo sustentan son válidos y si podrían ser implementados en la práctica, en un entorno comercial, sin sacrificio excesivo. Para los sistemas de riego por aspersión estas preguntas han sido contestadas en gran medida afirmativamente, como lo demuestran los rendimientos de azúcar relativamente altos obtenidos en un entorno comercial. Nuevas variedades cultivadas en el proyecto piloto tuvieron contenidos relativamente altos de cristales recuperables estimados (CRE) y rendimientos promedio de CRE de 18,6 t/ha para los cultivos de tres cañas plantas, dos primeras socas y una segunda soca cosechados hasta la fecha, en aproximadamente 300 ha. Otros beneficios incluyen aumento en la carga útil de aproximadamente 6%. Las principales ventajas del nuevo sistema de riego por gravedad son que permite un uso relativamente eficiente de la energía y el agua; es simple de operar y mantener, y permite a los usuarios sacar provecho de los beneficios sinérgicos del SATC. En el sitio de demostración, los rendimientos de CRE para el cultivo de cañas plantas fue 19 t/ha con sólo 7 ML/ha de agua de riego. Tipicamente, los campos de caña planta con mejores rendimientos de la industria producen aproximadamente 15 t ERC/ha y se pueden utilizar 13-19 ML/ha de agua de riego. Se recomienda la adopción generalizada del SATC. Asociaciones representativas pudieran desarrollar y ofrecer adecuados "Servicios del Sistema Agrícola (SSA)" adquiriendo los equipos y conocimientos necesarios para proveer SSA tanto para grandes y pequeños productores sobre una base de recuperación de costos.

**Palabras clave:** Tráfico controlado, sistema de cultivo, riego de superficie