SUCCESSFUL SITE-SPECIFIC FERTILISATION WITH ORGANIC BY-PRODUCTS

By

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Abstract

RAPIDLY increasing fertiliser prices are having a strong impact on the economics of sugarcane production. To control production costs, fertiliser applications are reduced and thus productivity is compromised. At the same time, pressure for proper management of organic, agro-industrial by-products is increasing as environmental regulations are becoming stricter. This situation provides for a unique, win-win opportunity to substitute expensive, synthetic fertilisers with readily available, organic by-products. At San Carlos Mill in Ecuador, we are using all the filter cake and vinasse from our own operation, and purchasing chicken manure from a large-scale chicken firm, in a site-specific fertilising schedule. The 17 845 ha plantation is divided into 1382 lots, and nutrient requirements are calculated for each lot individually based on soil and leaf analyses, cane variety, expected production, climate, and soil type. In 2008, we applied 49 249 t of filter cake and 13 023 t of chicken manure on 1506 and 2050 ha, respectively, of mainly plant cane. The organic by-products were applied fresh and supplemented with synthetic fertiliser where needed. Cane-tissue analyses and harvest data show that cane fertilised with organic by-products had similar growth and nutrient-uptake patterns, and recorded similar cane and sugar yields, compared to the cane that received only synthetic fertiliser, while fertilisation cost was reduced by up to 25%. In 2009, we have added the vinasse from the distillery to our fertilisation program and envisage purchasing only urea in the near future since, with the use of by-products, we are self-sufficient in P and K.

Introduction

Sugarcane removes large amounts of nutrients from the soil. Subirós Ruiz (2000) reports a wide range of values for nutrient uptake found in the literature, with an average value of 1.09 kg N, 0.24 kg P_2O_5 and 1.90 kg K_2O per tonne of cane (tc). Differences can be attributed to cane variety and nutrient availability in the soil.

As sugarcane is harvested, all the nutrients in the stalk are removed from the field; when cane is burned, additional nutrients are lost to the atmosphere (Núñez and Spaans, 2007). In order to avoid loss of soil fertility and maintain productivity of the land, these nutrients need to be returned to the soil. Since the green revolution, synthetic fertilisers have been the primary nutrient source, because; i) they are highly concentrated reducing storage, transportation, and application costs; ii) their nutrient content is well-known and uniform; and iii) once dissolved in the soil solution, they are readily available for plant uptake. Moreover, they were less expensive on a per kg nutrient basis compared to organic fertilisers.

Since 2004, however, synthetic-fertiliser prices have tripled and it appears that they will not be reduced in the near future (Figure 1). These high fertiliser prices have an enormous economic impact on sugarcane producers, as fertilisation is one of the principal components of the crop-management budget.

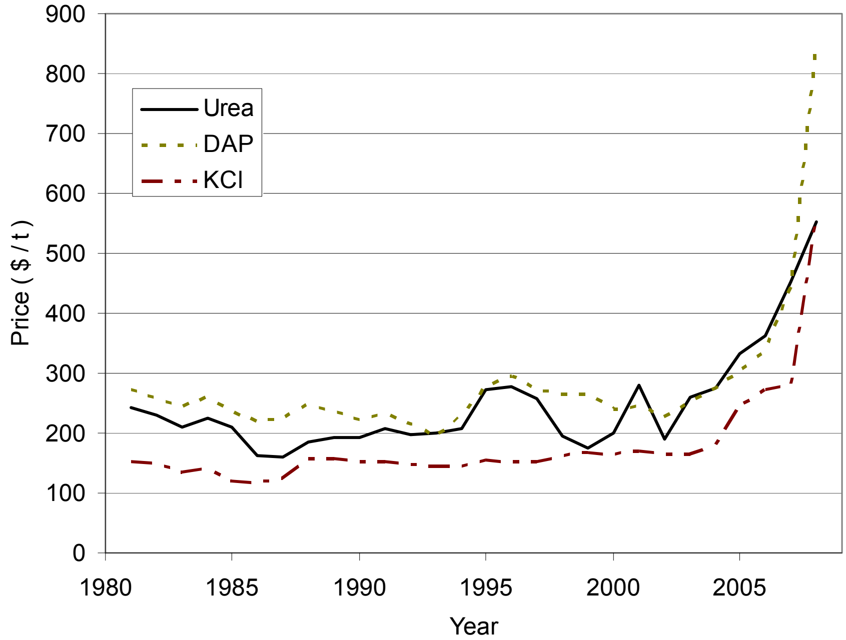

Fig. 1—Historic average US-farm prices of urea (46:0:0), DAP (18:46:0), and KCl (0:0:60). Note the strong increase since 2004. (source: http://www.ers.usda.gov/Data/FertilizerUse/). Similar increases occurred in Ecuador.

At the San Carlos Mill in Ecuador (2°13’14.61’ S and 79°24’32.23’ W), interest has always existed in the use of organic by-products from the factory as nutrient sources for the cane crop. However, manipulation and transport of the by-products used to be much more expensive compared to the use of conventional, synthetic fertilisers, as large quantities of organic products are needed because their nutrient content is relatively low.

Organic by-products that could serve as nutrient sources include filter cake (high P and medium N content), boiler ash (high P and K content), and vinasse (high K content). At the San Carlos Mill, filter cake and vinasse have been mixed with the irrigation water for the sugarcane crop since 1985, and the area that received this irrigation water (Sector 3, 3064 ha), has increased production ever since.

Prior to 1985, Sector 3 produced on the average 1 tc/ha less than the rest of the plantation (14 781 ha). After 1985, its productivity started to increase gradually and, since 1990, it has recorded 8 tc/ha more than the rest of the plantation, corresponding with a 12% productivity increase. Moreover, Sector 3 receives only N-fertiliser as soil analyses indicate high values of P and K, resulting in a lower production cost than other sectors that receive N, P and K fertilisers.

In accordance, Morris *et al*. (2007) reported that applying 246 t/ha of mill mud on a sandy soil one time before planting increased fresh cane and sucrose yields by 200% compared with low fertilisation treatments and 26% compared with adequate fertiliser treatments (two year average). Soil P and K also increased with this application of mill mud.

However, over that same period, sucrose recovery from Sector 3 has dropped from 0.4 kg sucrose/tc above, to 4.7 kg sucrose/tc below the average of the rest of the plantation. We attribute this to K build up in the soil from the vinasse to levels above 0.4 cmol/kg which result in reduced crystallisation of sucrose in the factory (Körndorfer, 1990). Another interesting observation is that, although P and K levels in the soil are much higher, the organic matter content in the soil is the same in Sector 3 compared to the rest. We suspect that the organic matter from the filter cake, that remains on the soil surface as the irrigation water infiltrates, is being burned at harvest. That would also explain why, in spite of receiving the same N application, foliar levels of N in the sugarcane of

Sector 3 are similar to those of the rest of the plantation, since the N of the organic matter of the filter cake is also lost during the burning of the cane.

These results from an unreplicated field experiment provided practical evidence that filter cake and vinasse do break down in the soil and liberate nutrients to the soil. In field experiments in South Africa, Roth (1971) reported that the filter cake treatments, on average, gave highly significant increases in biomass yield when compared with the control but they also depressed sucrose content in cane. The results showed that bacteria, actinomycetes, fungi, and nematodes are closely associated with the increasing stability of the soil aggregates. The fungi in the control samples were only present in the form of spores or chlamydospores, and there was no pronounced mycelial network. By using different methods, it was possible to show that filter cake-treated soil had a very active mycelial network which was able to hold separate soil particles together.

The soils of Sector 3 have become quite rich in P and K and could sustain a healthy crop for many years even without receiving any more filter cake, vinasse or synthetic P and K fertilisers; in fact, the elevated K levels in the soil could be affecting sucrose recovery. In order to use these precious by-products in the rest of the plantation, however, they would have to be brought up-slope since irrigation is gravity fed, hence requiring a completely different application method.

As a response to the high fertiliser prices, in 2008 all the filter cake produced in the factory of San Carlos Mill and chicken manure purchased from a third party, were applied to mainly plant cane but also to ratoon cane, in P deficient soils. The objectives of this paper are to present the logistics of these commercial-scale operations, the model that was developed to incorporate the nutrients contained in the by-products into the fertilisation program, and the crop response and cost-benefit analysis of this operation.

Site-specific, organic fertilisation

The chicken manure was purchased from Ecuador's largest chicken producer and the filter cake came from our own factory. Chemical analyses of the organic by-products used in the San Carlos Mill are presented in Table 1.

Table 1—Total nutrient and water content (average ± std; n = 72) and equivalent N-P_2O_5-K_2O value on a fresh weight basis for the organic by-products used to fertilise the soils of San Carlos Mill. Values are based on 2009 prices of US\$500/t urea, US\$600/t DAP and US\$900/t KCl. Theoretical value is based on total nutrient content, while practical value is based on plant-available nutrient content.

					Value	
	N	P_2O_5	K_2O	Water	Theoretical	Practical
	kg				US$	
Filter cake (/t)	2.7±0.4	13±3	1.4±0.3	690±27	16.46	12.35
Chicken manure (/t)	15±2	22±4	19±4	240±46	64.14	48.11
Vinasse (/m^3)	–	–	7–10	–	12.75	9.56

The chemical composition of the by-products was periodically monitored to control their quality. The results from the filter cake are rather constant (Table 1). The chicken manure was also constant and any variation in nutrient content was most likely due to the cleaning cycles of the floor of the chicken barn.

Those from the vinasse fluctuated between 7 and 10 probably depending on the molasses–cane juice mix that is used in the distillery. Note that vinasse data are shown for reference purpose, since vinasse was not incorporated into the site-specific fertilisation program until 2009, and field evaluations are not available yet.

The efficiency of organic by-products depends on the availability of its nutrients, which in general is much higher for animal by-products than for vegetative material, because animal by-products can be considered an end-product of an optimum decomposition of vegetative material. Once applied to the soil, the decomposition rate depends on the microbial activity, which accelerates under conditions of medium-high temperatures, humidity and biodiversity.

Composting is usually recommended before applying organic by-products, mainly to control the decomposition process and obtain a higher quality product, but also to kill pathogens by the high temperatures generated during the composting process, and to reduce weight and water content and therefore transportation costs. Composting, however, is expensive both in investment of machinery and infrastructure, as well as in operation. We prefer to have the decomposition occur in the soil, stimulating biological activity where it is most needed and where liberated nutrients and leachates are immediately available for plant-uptake. Both filter cake and vinasse are exposed to high temperatures in the factory, so they should not contain pathogens. Chicken manure could contain animal-based pathogens, which we did not expect to affect the cane crop. In conclusion, we chose to apply the by-products directly to the soil without any prior treatment.

In our model to calculate fertiliser rates, we assumed conservative values for nutrient availability of the by-products, because we did not want to compromise cane production. Moreover, the sudden jump in synthetic fertiliser prices forced us to skip the experimental stage and to go straight to a commercial-scale application, and fortunately economic returns of the project were favourable enough that we could be conservative. Since filter cake is a raw vegetative material, the rate of release of both N and P was estimated at 50% in the first year and 25% in the second year. The remaining 25% would stay in the stable, humic fraction in the soil. The chicken manure was assumed to liberate 75% of its N and P in the first year, with 25% remaining in the humic fraction of the soil. Potassium does not form an integral part of the carbon structures because it does not form covalent bonds; instead, it only forms ionic bonds which do not require microbial breakdown, but only water for it to become available as K^+ for plant uptake. We assumed an availability of 75% of the K in all by-products in the first year; the other 25% would be leached or maintained in the soil.

Taking into account these efficiencies, the practical, equivalent NPK-value can be calculated (Table 1). With respect to the practical value of filter cake, note that $8.75 is available in the first year and $3.60 the following year.

The plantations of the San Carlos Mill are divided into 1382 lots with an average size of 12.91 ha (Spaans and Núñez, 2006). On every lot, soil analysis is done immediately after harvest, and leaf analysis is done at 3.5, 5.5, 8.5 and 10.5 months after harvest. Soils are neutral, neither saline nor sodic, and rich in Ca and Mg. Therefore only urea, DAP and KCl are used in the fertilisation program. Based on soil and leaf analyses, cane variety, expected production, soil type and climate, the amount of N, P_2O_5 and K_2O that needs to be applied in every lot is being calculated.

On commercial lots, applications were made of either filter cake at a rate of 30 t/ha or chicken manure at a rate between 8–10 t/ha. The amount of by-product applied to a lot, multiplied by its nutrient content (see Table 1) and multiplied by the release rate discussed above, was subtracted from the total nutrient requirement of that lot. The difference was then applied separately by conventional means with synthetic fertilisers.

As a consequence of the site-specific management and the large number of lots, many different combinations of NPK application rates are used. Table 3 shows the most common nutrient requirements on San Carlos lots, and possible scenarios of how these nutrients were applied with by-products, synthetic fertiliser, or a combination of the two.

To evaluate the effect of the filter cake applications, in 2008 six pairs of commercial lots with plant cane were selected, such that within each pair both lots had the same soil type, planting date, and cane variety; however, one lot was fertilised with synthetic fertiliser only and the other with a by-product and supplemented with synthetic fertiliser where needed. To evaluate the chicken manure application, seven pairs were selected in the same way. On every one of the selected lots, crop growth was monitored monthly by measuring stalk height and diameter on the same 10 plants in five sites within the lot; population was measured on the same five sites, counting the number of stalks present in 15 m. In addition, Crop-log data (Clements, 1970) in every lot were collected on plant tissue at 3.5, 5.5 and 8.5 months after crop-start date. During the harvest of 2009, cane yield and sucrose yield data of each lot were obtained from the commercial data.

Field operations

In order to process filter cake directly and without water, the filters were relocated outside the factory and the filter cake now falls directly into a dump truck. The filter-cake truck was then weighed on the same scales used to weigh the cane trucks, allowing for precise monitoring of filter cake production in the factory, an additional advantage of the project. The truck then proceeded to the field and dumped the filter cake on one side of the lot, where it accumulated until the total amount was deposited. Chicken manure was provided directly from the chicken barns to the mill by truck.

In the field, one front-loader lifted up the by-product from the ground and put it into a spreader. The spreader is a V-shaped wagon with a conveyor belt on the bottom that is driven by a hydraulic pump. The wagon has a volume of approximately 7 m^3 and can store 4 t of chicken manure or 6 t of filter cake. The team consisting of one front-loader, three 110 HP tractors each hauling a spreader and one supervisor could cover about 2.1 ha/h.

In plant cane, the equipment that makes the furrow also applied the synthetic fertiliser (where needed) in one single operation. Then either the chicken manure or the filter cake was applied in the furrow, the cane was planted on top of and in direct contact with the by-product, and then the furrow was closed and irrigation water applied. In ratoon cane, by-products were applied right after harvest in a separate operation. Then, the conventional equipment was used that in one single operation incorporates synthetic fertiliser, cultivates the inter-row, and reforms the furrow. Although the cultivation incorporates the by-products, these will never be placed as close to the roots of the cane stool as in plant cane. Therefore, in the selection of where to apply by-products, preference was given to plant cane.

Results and discussion

In 2008, 49 249 t of filter cake was applied to 1506 ha and 13 023 t of chicken manure to another 2050 ha, substituting 187 t of urea, 616 t of DAP and 314 t of KCl. Organic by-products contain all three macro nutrients in a more or less fixed proportion, and it is rare that their proportion matches exactly the sugarcane nutrient requirements of a lot. Thus, the amount of by-product to be applied in any lot can be calculated according to two strategies. One is fulfilling the requirement of all three nutrients, which inherently implies that two of the three nutrients will be applied in excess.

The other strategy is to apply only the amount necessary to fulfil the requirement of one nutrient, and complement the requirement of the other two with synthetic fertiliser. The second choice takes full advantage of the value of the organic by-product according to Table 1; however, a second application with synthetic fertiliser is needed. With the first choice, fertilisation is done in one operation, but the economic values reported in Table 1 will not be reached. Obviously, the optimum strategy will depend on the cost of acquisition, transport, and application of synthetic fertiliser and by-products.

Field evaluations

The evolution of stalk height and diameter throughout the growing season followed a normal pattern in all of the six pairs of lots for the filter cake evaluation (Figures 2 and 3), as well as in the seven pairs of lots for the chicken manure evaluation.

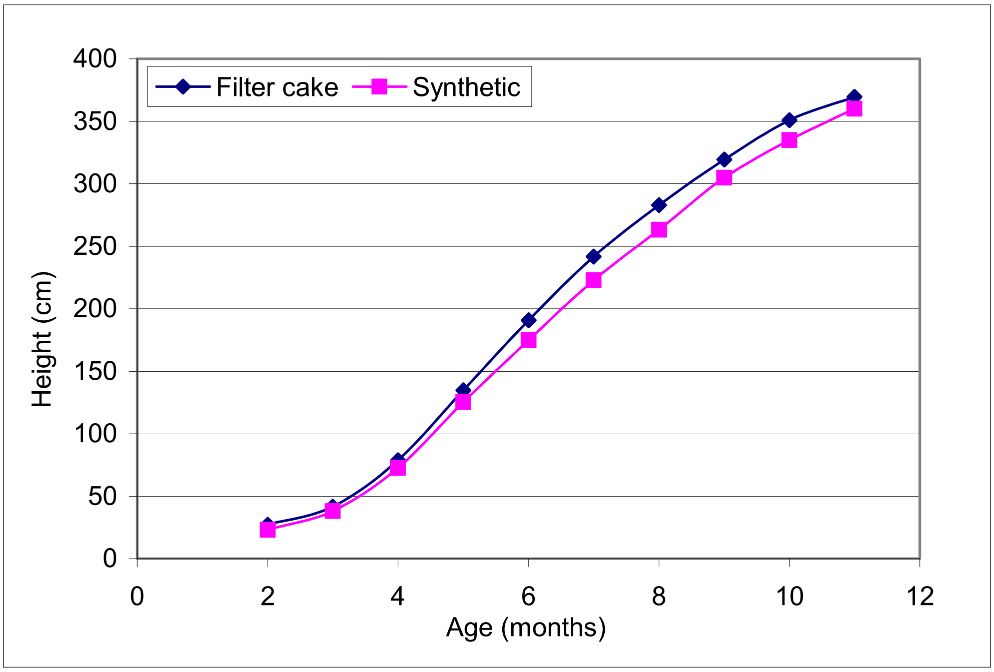

Fig. 2—Stalk height to the top visible dewlap of sugarcane fertilised with filter cake (♦) or synthetic fertiliser only (■). Each datum is an average of 300 plants. The data from the cane fertilised with chicken manure and its synthetic comparison (not shown) followed a similar pattern.

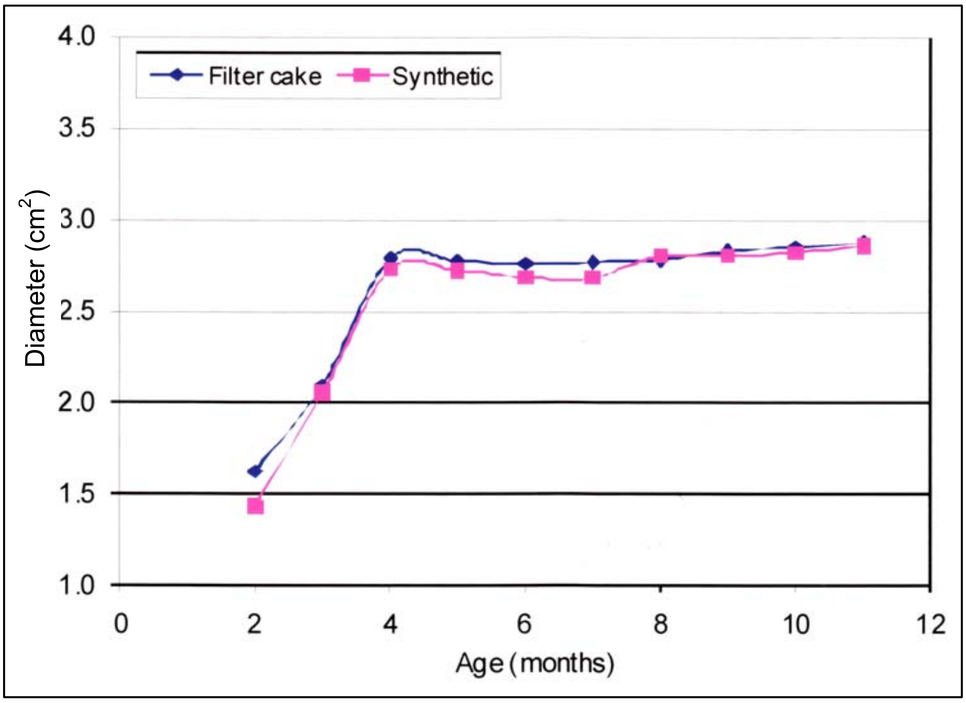

Fig. 3—Stalk diameter at the base of sugarcane fertilised with filter cake (♦) and synthetic fertilisers only (■).Each datum is an average of 300 plants. Data from the cane fertilised with chicken manure and its synthetic comparison (not shown) followed a similar pattern.

Detailed agronomic data for all evaluations from the pairs of lots are shown in Table 2. No significant differences in any of the agronomic parameters were found between the organically fertilised and the synthetically fertilised cane (Tukey test; P < = 0.05).

The Crop-log values (Table 2) for leaf-N and sheath-K levels at 3.5, 5.5 and 8.5 months after planting and P content of the stalk at 5.5 months, indicate that nutrient absorption occurred at normal rates for both organic fertilisations as compared to synthetic fertilisations. Since roughly the same amounts of nutrients were applied within each pair (organic-synthetic) of comparative lots, the data suggest that the liberation of nutrients from the organic by-products occurred at a sufficiently high rate to keep up with the instantaneous nutrient requirement of the crop, at any time. This is remarkable as no composting or any other pretreatment of the by-products was done.

One of the concerns of using organic fertiliser is the slow release of N and thus continuous N availability in the soil, possibly hampering the maturing of the crop. The data presented in Table 2, however, show that the decline of N content of the leaves as the cane develops follows a similar pattern in the organically compared to the synthetically fertilised cane.

We should bear in mind that the prime objective was not to improve crop production, but to substitute expensive synthetic fertiliser with readily available organic by-products to reduce costs. The results so far indicate that the assumptions in our model to quantify this substitution are valid.

In addition to the plant cane evaluations, we did similar observations on four pairs of ratoon cane lots. No significant differences (Tukey test; P < = 0.05) were found in any of the agronomic parameters between the ratoon cane fertilised with chicken manure cane fertilisedcompared to the cane fertilised with synthetic fertiliser.

Table 2—Growth indicators, Crop-log and yield data (average ± std) of sugarcane fertilised with filter cake and chicken manure, each compared with its synthetic fertiliser control fields. For growth indicators, n = 300 plants for filter cake evaluation, and n = 350 plants for chicken manure evaluation. Crop-log data are from five random plants selected in each lot, and cane and sucrose yield data were obtained from the commercial harvest of the entire lots. None of the agronomic parameters were significantly different (Tukey test; P < = 0.05), neither for the filter cake vs. its synthetic comparison, nor for the chicken manure vs. its synthetic comparison.

	Filter cake evaluation		Chicken manure evaluation	
	Filter cake	Synthetic	Chicken manure	Synthetic
Growth indicators at 11 months:				
Millable height (cm)	298±26	290±45	266±26	282±26
Stalk diameter at centre (cm)	2.8±0.1	2.8±0.2	2.5±0.3	2.7±0.2
Stalk population (stalks/m)	6.6±1.1	6.1±1.4	6.1±1.4	6.7±1.8
Foliar N (%):				
At 3.5 months	2.19±0.3	2.19±0.3	2.30±0.3	2.23±0.2
At 5.5 months	1.90±0.2	1.85±0.3	1.96±0.3	1.92±0.3
At 8.5 months	1.62±0.2	1.63±0.2	1.64±0.2	1.64±0.2
Sheath K (%):				
At 3.5 months	0.51±0.03	0.50±0.05	0.55±0.07	0.53±0.07
At 5.5 months	0.46±0.08	0.53±0.06	0.57±0.06	0.51±0.08
At 8.5 months	0.60±0.07	0.61±0.03	0.58±0.09	0.58±0.07
Stalk P (API):				
At 5.5 months	2012±538	2073±495	1949±343	2061±890
Sheath weight (g):				
At 3.5 months	77±13	80±13	75±11	73±9
At 5.5 months	92±8	96±16	92±15	90±15
At 8.5 months	87±15	90±16	90±16	96±13
Cane yield (t/ha)	96±13	99±7	99±11	99±10
Sucrose yield (t/ha)	9.3±0.8	9.3±0.9	9.3±1.1	9.8±0.8

In 2009, vinasse application was added as a component of the fertilisation program. To reduce transportation cost, 13 km of PVC pipes were installed in the ground to transport vinasse at a rate of 20 L/s to strategic sites in the field, where small ponds lined with double-plastic layers serve as buffers that can store up to 1 day of vinasse.

From these ponds, vinasse was mixed with the irrigation water at a rate of approximately 1:100. In lots that might drain into natural creeks, vinasse was not used for irrigation; instead vinasse was applied directly with a 12 m^3 tanker hauled by a 140 HP tractor. Considering previous experiences in Sector 3 and the immediate availability of the K^+ ion as discussed above, we expect that the vinasse will substitute KCl and that K uptake by the crop will be normal. So far, the logistics prove to be satisfactorily; field evaluation data, however, are not available yet.

Cost/benefit analysis

The cost/benefit analyses of possible nutrient requirements are presented in Table 3. The greatest savings using organic nutrient sources occurred when P and K requirements were high, because DAP and KCl were, in 2009, more expensive than urea. Fertilisation costs could be reduced by up to 25% with organic by-products, with the additional advantages of; i) incorporating organic material into the soil; ii) properly managing organic by-product, and iii) adding, in general, more P and K than necessary due to the difficulty of exactly matching the N-P-K proportion with organic by-products and fine tuning the amounts applied. Although not considered in Table 3, filter cake application is expected to save an additional $108/ha in the following year when the remaining nutrients will be released.

The use of organic by-products becomes less profitable when P and K requirements are lower, as the cost/benefit compared to synthetic fertilisers is reduced.

Costs and benefit will vary from one mill to another, depending on transportation cost and distance, chicken manure prices and efficiency in field logistics. Application costs ranged from US$27 (chicken manure) to US$33/ha (filter cake).

Transportation cost of the chicken manure was included in the price (US$28/t) as it was transported from the chicken barn directly to the lot, while transport of the filter cake from the mill to the lot averaged US$1.80/t. Investment in the spreaders (3), tractors (3) and front-loader (1) are in the order of US$220,000, which was paid back within the first year of the project. Application and transportation costs in Ecuador are relatively low due to highly subsidised fuel prices ($0.28/L diesel).

Table 3—Fertiliser rates and cost/benefit analysis for some of the most typical nutrient requirements calculated for San Carlos cane plantations. For every nutrient requirement, three possible scenarios are presented; using synthetic fertilisation (first row), chicken manure (second row) or filter cake (third row). As can be seen, chicken manure and filter cake fertilisations may require additional synthetic fertiliser depending on the rate applied and the specific nutrient requirement of the lot.

Nutrients requirement	Chicken manure	Filter cake	Urea	DAP	KCl	Total cost	Savings
$N–P_2O_5–K_2O$ (kg/ha)	t/ha	t/ha	kg/ha	kg/ha	kg/ha	US$/ha	%
120–130–130	–	–	150	283	217	$ 440	
	11	–	–	–	–	$ 329	25%
	–	30	173	–	164	$ 321	27%
120–65–80	–	–	206	141	133	$ 307	
	6	–	114	–	–	$ 249	19%
	–	30	173	–	81	$ 247	20%
120–0–80	–	–	261	–	133	$ 250	
	6	–	114	–	–	$ 249	1%
	–	30	173	–	81	$ 247	1%
120–65–0	–	–	206	141	–	$ 188	
	5	–	139	–	–	$ 234	–24%
	–	30	173	–	–	$ 174	7%

Conclusions

Organic by-products were successfully incorporated into the fertilisation program at San Carlos Mill in Ecuador. Organic nutrient application was fully mechanised and optimised so that by-products could substitute synthetic fertiliser in a wide range of nutrients requirements.

Due to high fertiliser prices, the cost-benefit of this project was extremely positive, but even at much lower fertiliser prices, the use of by-products is still profitable. Moreover, their contribution to the production system is not limited to providing N, P and K, but also in micro nutrients and valuable organic matter that improves soil structure and stimulates biological activity in the soil.

A field of one hectare that produces 80 tc produces about 2.4 t of filter cake which corresponds to 30 kg of P_2O_5, which, in turn, is similar to the amount of P extracted from the soil by that same crop. Thus, returning filter cake back to the soil completes the nutrient cycle for P and can as such be considered a sustainable practice.

The same is true for vinasse, which is the sink for all the K that was present in the cane juice. From a theoretical point of view this is logical, as the export products from the industry (sugar and ethanol) contain only C, H and O; all nutrients are removed in the process and evacuated as by-products. Requisite for the sustainability argument, however, is that the by-products are being returned to all fields that are being harvested, even the distant ones where transport costs are higher, including the fields of cane farmers that sell their cane to the mill.

We envisage that the only synthetic fertiliser that we will need in the future will be urea; DAP and KCl will be substituted entirely with filter cake and vinasse; if not, there are still other products such as chicken manure and boiler ashes to complement the fertilisation program.

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FERTILISATION ADAPTEE AU SITE AVEC DES SOUS PRODUITS ORGANIQUES

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MOTS CLES: Fertilisation Organique, Gestion Adaptée au Site, Canne à Sucre, Gestion Des Déchets

Résumé

L'AUGMENTATION rapide des prix des engrais à un fort impact sur l'économie de la production de canne à sucre. Pour contrôler les coûts de production, les applications d'engrais sont réduites et la production est ainsi compromise. En même temps, l'incitation à bien gérer les sous produits agro-industriels organiques augmente du fait des lois environnementales qui deviennent de plus en plus strictes. Cette situation est une occasion unique de remplaces les engrais minéraux coûteux par des sous produits organiques facilement disponibles. A L'usine de San carlos, en Equateur, toutes les écumes et les vinasses produites, ainsi que les fientes de poules achetées à une société d'élevage sont utilisées dans un schéma de fertilisation adapté aux parcelles. Les 17845 ha de la plantation sont divisés en 1382 lots. Les besoins en éléments minéraux sont calculés pour chaque lot à partir des analyses de sol et des analyses foliaires: de la variété; de la production espérée; du climat et du type de sol. En 2008, nous avons épandu 49349 T d'écumes et 13023 T de fientes de poulet sur 1506 et 2050 ha respectivement, en majorité sur des cannes plantées. Les sous produits organiques furent appliqués en frais et complémentés avec des engrais minéraux quand il y en avait besoin. Les analyses de plantes et les résultats de récolte montrent que les cannes fertilisées avec des sous produits organiques avaient des croissances, des dynamiques de mobilisation, des rendements en canne et en sucre similaires à ceux des cannes fertilisées uniquement avec des engrais minéraux., alors que les coûts de fertilisation étaient réduits de 25%. En 2009, de la vinasse provenant de la distillerie a été ajoutée au programme de fertilisation et des achats uniquement d'urée sont envisagés dans un futur proche puisque avec l'utilisation des sous produits, les plantations sont autos suffisantes en P et en K.

UNA FERTILIZACIÓN DE SITIO ESPECÍFICO EXITOSA CON SUBPRODUCTOS ORGÁNICOS

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PALABRAS CLAVES: Fertilización Orgánica,
Manejo de Sitio Específico, Caña de Azúcar, Manejo de Desechos.

Resumen

EL RÁPIDO AUMENTO de los precios de los fertilizantes está causando un fuerte impacto en la economía de la producción de caña de azúcar. Para controlar los costos de producción se reduce la aplicación de fertilizantes y en consecuencia se compromete la productividad. Al mismo tiempo está aumentando la presión para un manejo apropiado de los subproductos orgánicos agroindustriales a medida que las regulaciones ambientales se vuelven más estrictas. Esta situación ofrece una oportunidad única para sustituir los caros fertilizantes sintéticos por subproductos orgánicos fáciles de conseguir. En el ingenio San Carlos en Ecuador, se está utilizando toda la cachaza y la vinaza proveniente de la fábrica y comprando estiércol de pollo a una firma productora de pollos en gran escala, lo cual se utiliza en un esquema de fertilización de sitio específico. Las 17 845 ha plantadas están divididas en 1382 lotes, y los requerimientos de nutrientes son calculados individualmente para cada lote en base a análisis de suelo, análisis foliares, cultivares, producción esperada, clima y tipo de suelo. En 2008 se aplicaron 49249 t de cachaza y 13023 t de estiércol de pollo en 1506 y 2050 ha, respectivamente, principalmente en caña planta. Los subproductos orgánicos se aplicaron frescos y suplementados con fertilizantes sintéticos donde fue necesario. Los análisis de tejidos de la caña y los datos de cosecha mostraron que la caña fertilizada con los subproductos orgánicos presentó similares patrones de crecimiento y absorción de nutrientes, y registró similares rendimientos de caña y azúcar, que la caña que recibió solamente fertilizantes sintéticos, mientras que el costo de fertilización se redujo hasta un 25%. En 2009, se incluyó la vinaza proveniente de la destilería al programa de fertilización y se prevé para el futuro próximo la compra solamente de urea, ya que con el uso de estos subproductos se será autosuficiente en P y K.