



Economic and production indicators of the sugar industry in Tucumán, Argentina, 1994-2017

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ABSTRACT

The sugar agro-industry is one of the main industrial activities in Tucumán. In 1992 the industry was deregulated. This study analyses the changes in the sugar sector in Tucumán from 1994 to 2017, using several economic and production indicators across three sub-periods: 1994-2001; 2002-2009; and 2010-2017. The variables analysed were planted area, cane yield, sugar recovery, sugar and ethanol production, sugar exports, domestic price of white sugar, direct production, harvest and transport costs, and break-even point for a frequently used crop-management scheme. From 1994 to 2017, planted area, production, cane yield, sugar recovery and local white sugar price increased at an average annual rate of 0.79%, 3.26%, 1.32%, 0.14% and 1.01%, respectively. Direct costs per hectare grew at an annual rate of 3.01%. Harvest and transport costs represented about 50% of the direct cost over the evaluated period. It was concluded that from 1994 to 2017, production, productivity, prices, costs and break-even point increased. However, in the last sub-period (2010-2017), despite the growth of sugar production and planted area and productivity diminished and costs and the break-even point continued to rise. This was largely due to an increase per tonne in harvest and transport costs, at an annual rate of 9.39% and 6.95%, respectively. Over the full study period, production of sugarcane ethanol as a by-product increased and positively influenced the local white sugar price to reach the highest recorded levels.

Key words: Planted area, production, break-even point, sugarcane yield, costs.

RESUMEN

INDICADORES ECONÓMICOS Y DE PRODUCCIÓN DE LA INDUSTRIA AZUCARERA EN TUCUMÁN, ARGENTINA, 1994-2017

La agroindustria azucarera es una de las principales actividades industriales en Tucumán. En 1992 la industria fue desregulada. Este estudio analiza cambios ocurridos en el sector azucarero en Tucumán luego de la desregulación desde 1994 hasta 2017. Para esto se observó el comportamiento de varios indicadores económicos y de producción en tres subperiodos: 1994-2001; 2002-2009 y 2010-2017. Las variables analizadas fueron área sembrada, el rendimiento cultural de la caña, el rendimiento fabril o recuperación de azúcar, la producción de azúcar y etanol, las exportaciones de azúcar, el precio interno del azúcar blanco, los costos directos de producción, cosecha y transporte, y el punto de equilibrio para un esquema de manejo del cultivo de uso frecuente en la provincia. De 1994 a 2017, el área sembrada, la producción, el rendimiento de la caña, la recuperación del azúcar y el precio local del azúcar blanco aumentaron a una tasa promedio anual de 0.79%, 3.26%, 1.32%, 0.14% y 1.01%, respectivamente. Los costos directos por hectárea crecieron a una tasa anual de 3.01%. Los costos de cosecha y transporte representaron alrededor del 50% del costo directo durante el período evaluado. Se concluyó que de 1994 a 2017, la producción, la productividad, los precios, los costos y el punto de equilibrio aumentaron. Sin embargo, en el último subperíodo (2010-2017), a pesar del crecimiento de la producción de azúcar y del área sembrada, la productividad disminuyó y los costos y el punto de equilibrio siguieron aumentando. Esto se debió principalmente al aumento en los costos por tonelada de cosecha y transporte, que crecieron a una tasa promedio anual del 9.3% y 6.5%, respectivamente. Durante este subperíodo, la producción de etanol de caña de azúcar como subproducto aumentó e influyó positivamente en el precio interno del azúcar blanco local que alcanzó niveles records.

Palabras clave: área plantada, producción, punto de equilibrio, rendimiento cultural de la caña de azúcar, costos.

Fecha de recepción: 1/11/2019 - Fecha de aceptación: 18/12/2019

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INTRODUCTION

Tucumán Province produces more than 60% of the sugar in Argentina, and the sugar agroindustry is one of the main economic activities in the province. Sugarcane represents 40% of the added value of the agricultural sector, and sugar more than the 30% of manufactured products in Tucumán. Consequently, the province depends on this industry (Pérez *et al.* 2005, 2007, 2011, 2016).

The sugarcane sector was protected by statute until 1992/1993, when the activity was deregulated. This reduced earnings, causing a deep economic crisis, with many workers losing their jobs and a significant number of sugarcane producers exiting the industry. In an attempt to improve income and competitiveness, the sugar sector introduced radical changes in its production structures and applied technology (Ahmed *et al.* 2007; Brito *et al.* 2005; Cuenya *et al.* 2005; Fandos *et al.* 2011; Giardina *et al.* 2005; Olea *et al.* 2005; Pérez *et al.* 2007, 2016; Romero *et al.* 2004, 2005, 2009; Soria *et al.* 2000).

The objective of this study was to analyse the changes in the sugar sector in Tucumán from 1994 to 2017 (after its deregulation), by comparing some of the economic and production indicators.

MATERIALS AND METHODS

We analysed the sugar sector in Tucumán using economic and production indicators during the 1994-2017 period. Average and annual growth rates were determined for the variables listed below over the whole period 1994-2017, and for three sub-periods, 1994-2001, 2002-2009 and 2010-2017 during which significant changes occurred in the industry. In 2001-2002, new cultivars were introduced, and the lengths of the field rows were increased to improve machinery efficiency. In 2010-2011 there was an increase in the area planted, and the productivity per hectare decreased.

The variables analysed were:

- For Tucumán: planted area (ha), cultural yield (sugarcane in t/ha), production or manufacture yield (%), sugar production (t), direct costs of production, harvesting and transport (\$/ha), break-even point (sugar t per ha), and white sugar prices (\$/t).

- For Argentina: sugar exports (t) and sugarcane bioethanol production (t).

- Others: international sugar price (contracts No. 5 and 11 in USD/t).

Data series were gathered from different institutions: Argentine Sugar Centre (CAA) 2018, Tucumán Regional Sugar Centre (CART), Secretary of Energy of the Argentine Nation (SENA) 2017, Secretary of Domestic Trade of Tucumán (SCIT), National Institute of Statistics and Census (INDEC), and Obispo Colombres

Agroindustrial Experimental Station (EEAOC).

Where relevant, profitability was measured and refers to the benefits obtained by making an investment, defined as the difference between gross income and the direct costs incurred in the production process.

Gross income was calculated using the average white sugar price recorded for each harvest period (from May to November in each season), average cultural yield, average factory yield, and participation (it represents the percentage of sugar received by farmers at each harvest). Gross income was expressed in constant pesos (Argentina's currency) per hectare (\$/ha) as:

$$\text{Gross Income (\$/ha)} = \text{White Sugar Price (\$/t)} \times \text{Average Cultural Yield (sugarcane t/ha)} \times \text{Average Factory Yield (\%)} \times \text{Participation (\%)}$$

The average local white sugar price was the price of 1 t of white sugar set by sugar mills in Tucumán, as recorded by CART (1990-2008) and by SCIT from 2009 onwards. Average price was expressed in constant pesos per tonne (\$/t).

Sugarcane yield was a productivity measure representing tonnes of cane produced per hectare (t/ha). These data were supplied by CART (1990-2001) and EEAOC from 2002 onwards.

The sugar recovery or factory performance % represented the amount of sugar obtained from 1 tonne of sugarcane, expressed as a percentage (% of sugar per tonne of sugarcane). It depended on sugarcane quality, cultivar, milling efficiency, and time of harvest (climatic conditions influence sugarcane maturation), among others. When determining gross margin, average factory yield values for each harvest season in Tucumán were used. These data series were provided by CAA.

Participation was measured and in Tucumán, sugar mills generally pay farmers through the *maquila* system. This means that farmers receive part of the sugar extracted from their sugarcane as a payment. The amount of sugar that farmers receive to sell their cane to factories is variable. In this study, the formula used to calculate participation in the 1994/95-2014/2015 period was:

$$\text{Participation\%} = (\text{recovery of farmers' sugar in\%} - 0.09) \times 1.5 + 0.525.$$

This formula was used by many factories in Tucumán over a long time. Since 2015/16, many mills have considered a 58-60% participation as a payment to cane growers.

Sugarcane yield is a productivity measure that represents tonnes of sugar per hectare (t/ha). It depends on cane yield (sugarcane t/ha) and factory yield (%). Data series were compiled using data supplied by EEAOC and CAA.

Only direct costs were calculated, using a scheme that included cultural practices normally carried out in sugarcane plantations in the province of Tucumán. The

crop-management measures considered for calculation were representative of sugarcane plantations with yields ranging between 57 and 75 t/ha and were derived from crop management tasks, chemical weed control, fertilization with urea, and the use of ripeners (this last strategy only as of 2008/2009). Between 1994/1995 and 1996/1997, 30% of the cane was harvested semi-mechanically and 70% underwent full mechanical harvesting, whereas from 1997/1998 onwards, 100% of plantations were harvested with the latter method. An annual replanting of 20% of the sugarcane area was considered. In general, harvesting and transport services were paid per tonne. In order to restrict calculations to 1 ha, the average cane yield recorded for each harvesting season in Tucumán was used. A 25 km distance between plantations and sugarcane mills was assumed.

Expenditure on sugarcane planting, applications, harvesting and freight was calculated on the basis of contractors' pricing values. These costs, like the ones incurred for buying agrochemicals, were surveyed in each season. The data used in the calculation were requested by telephone or mail from vendors, contractors, factory employees and farmers. No taxes or administrative expenses were included.

The break-even point represented the level of an income or direct cost when the gross margin was zero, while the other variables remain constant (Pérez et al. 2011b, 2016):

$$\text{Break-even point (sugar t/ha)} = \frac{\text{Total cost (USD/ha)}}{\text{Sugar price (USD/t)}}$$

The data series were compiled by the EEAOC using their own data, and those provided by Centro Argentino del Azúcar (CAA) and Secretaría de Comercio Interno de

Tucumán (SCIT).

Prices and expenses were calculated in Argentinian pesos (legal tender in 2017) with the IPIM (Internal Wholesale Price Index). Data were supplied by the National Statistics and Census Institute (INDEC).

RESULTS

Planted area and production

During the 1994-2017 period, the area planted with sugarcane in Tucumán increased from 224,800 ha to 269,530 ha, at an annual average rate of 0.79%. Sugar production increased at a rate of 3.26%, starting with 640,413 t and reaching 1,338,204 t.

From 1994 to 2001, the sugarcane planted area decreased at an annual average rate of 2.87%, whereas production increased by 4.35%. However, in the 2002-2009 period, both variables increased at a rate of 2.85% and 5.77%, respectively. Furthermore, average sugar production for this period was 36% higher than in the previous period, and 4% lower than in the following period (Figure 1). The 2005/2006 season stood out, with a historic production record of 1,525,190 t in a planted area of 203,170 ha (one of the smallest areas planted with sugarcane in Tucumán between 1994 and 2017). Moreover, the average was 6.01 sugar t/ha, 37% and 22% higher than in the previous and subsequent periods, respectively.

Towards the end of the 2002-2009 period and until 2012, international sugar prices improved, with a corresponding trend in local white sugar prices. In addition, the government promoted the production of ethanol from sugarcane for ethanol-gasoline blends, which reduced

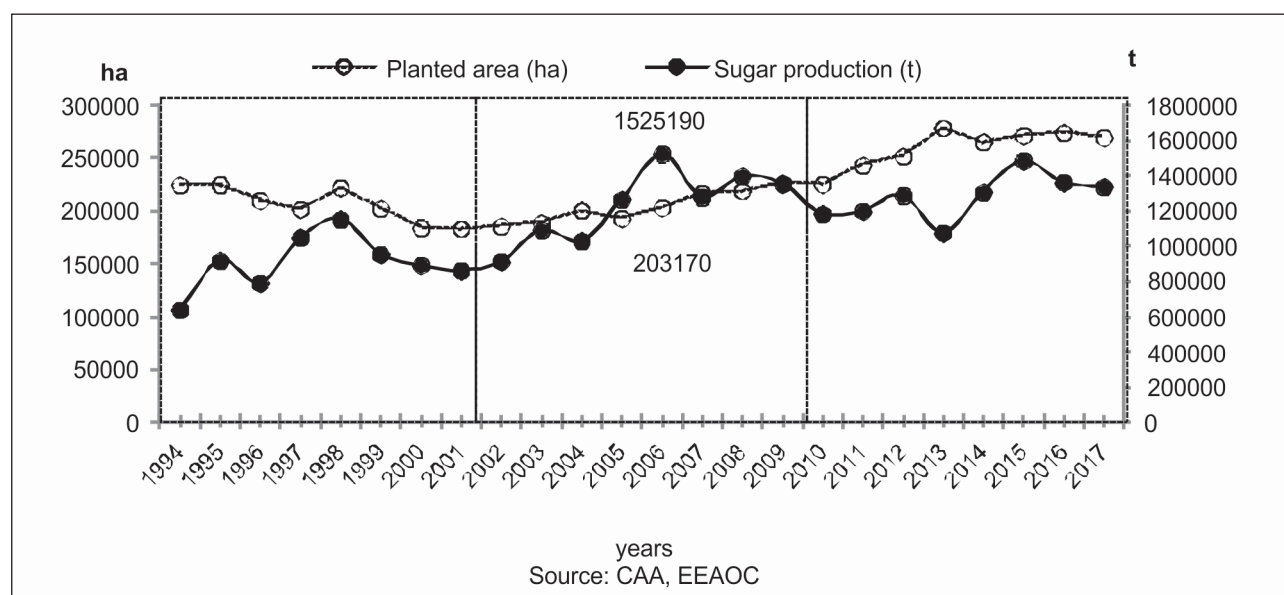


Figure 1. Sugar production (t) and sugarcane planted area (ha) in Tucumán during the period 1994-2017.

sugar surplus in the local market, having a positive impact on the domestic white sugar price.

Rising sugar prices promoted planting in marginal areas. During the 2010-2017 period, the sugarcane planted area grew by an average 2.59% per year, reaching a mean planted area of 259,971 ha, and production grew by an average 1.76% per year. However, planting in marginal areas may have been one of the factors that led to average cultural yield (productivity) reductions (Figures 1 and 2). Nevertheless, this expanded planted area helped to maintain sugar production levels of around 1.2 Mt of sugar in Tucumán.

Productivity: cane yield and sugar recovery

Sugarcane yield grew at an annual average rate of 1.32%, from 40.1 t/ha to 54.3 t/ha, between 1994 and 2017.

Sugarcane yield (productivity) increased at an annual rate of 3.84%, between 1994 and 2001, with a noticeable increase in the first years, and finally stabilised at 50 t/ha. Between 2002 and 2009, growth rate was 2.18% and average yield (60 t/ha) was 19% higher than in the previous period. During the 2002-2009 period, a historic yield of 69.4 t/ha was recorded (at the 2006 harvest season). In this sub-period an important renovation of the cane plantations began, new cultivars were introduced and the lengths of the field rows were increased to improve machinery efficiency.

Between 2010 and 2017, there was an annual average decrease in cultural yield (productivity) of 1.76%, and the average was 2% lower than that of the 2004-2009 period (Figure 2). In this sub-period the planted area grew but in areas marginal for sugarcane.

Sugar recovery in the 1994-2017 period had a very

low annual average growth rate of 0.14%. When comparing the sub-periods, the growth rate was positive in the 1994-2001 period, and negative in the 2002-2009 and 2010-2017 cycles, with values of 0.26%, 0.13% and 0.73%, respectively. In addition, there were differences among the averages recorded for each period, with the value for 2002-2009 (10.33%) being 7% and 5% higher than those for 1994-2001 and 2010-2017, respectively.

Sugar prices

Between 1994 and 2017, sugar price per tonne in contracts No. 5 and 11 increased from 345 to 432 USD/t, and from 268 to 353 USD/t, respectively (expressed in current dollars). In the same period, sugar price in the local market rose from 5919 \$/t to 7463 \$/t (expressed in Argentinian currency and considering values in 2017). In all three cases, annual average growth was around 1%.

Between 1994 and 2001, price trends of contracts No. 5 and 11 and of sugar in the local market declined. During the 2002-2009 period, international contracts grew by more than 10%, whereas the local price decreased by an average of 1.2% per year. Although the rate decreased, average local sugar price in this period was higher than in the previous one, and there were no significant fluctuations among seasons. During the 2010-2017 period, contracts No. 5 and 11 had a decreasing annual average rate of 4.86% and 4.54%, respectively, while the local price had a positive rate close to 1% (Figure 3). The average domestic price for this period was 64% and 55% higher than in the 1994-2001 and 2002-2009 cycles, respectively.

Sugar exports and bioethanol production

From 1994 to 2017, Argentina's sugar exports were

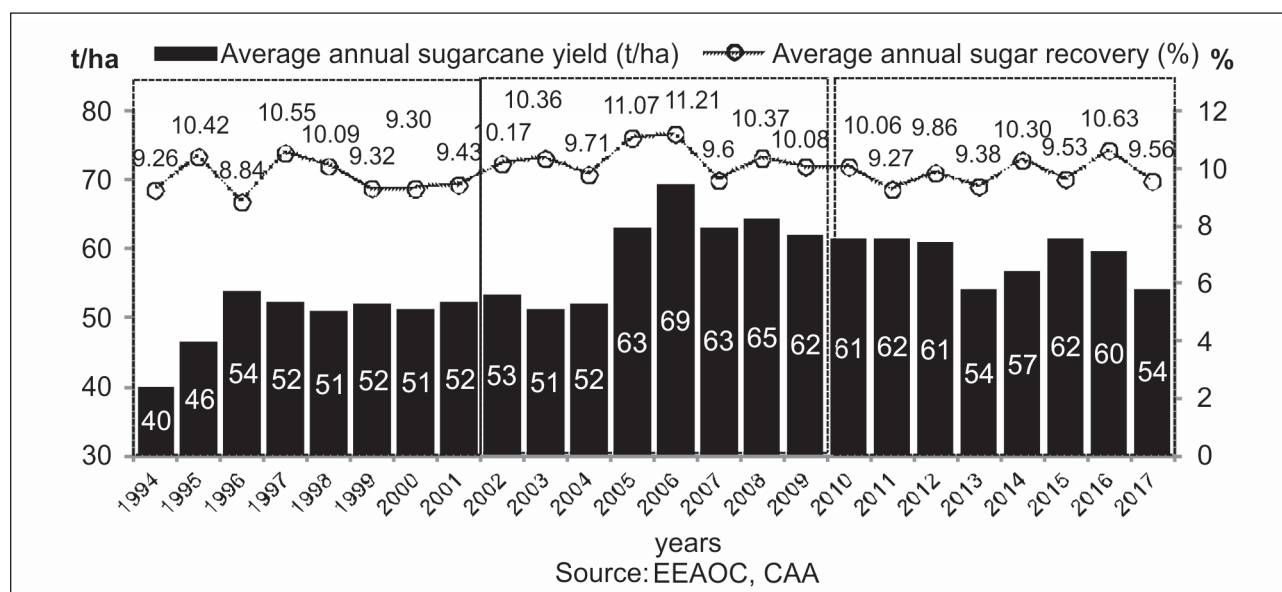


Figure 2. Average annual sugarcane yield (t/ha) and average annual sugar recovery (%) in Tucumán during the period 1994-2017.

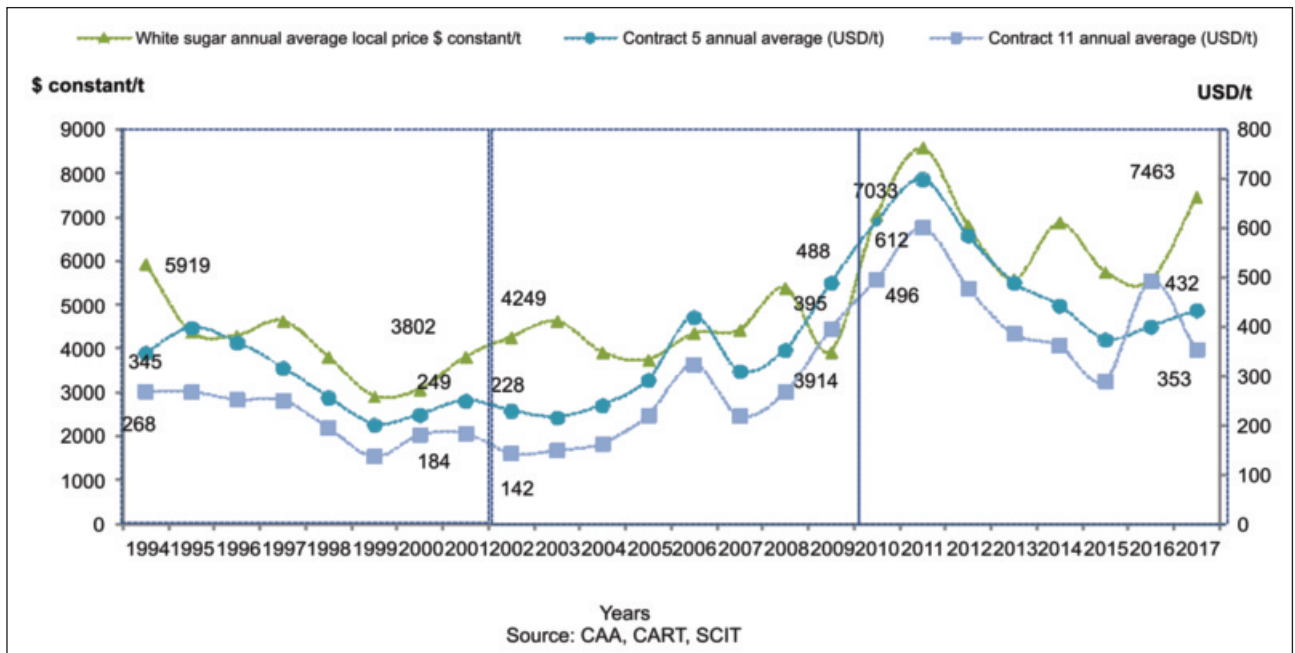


Figure 3. Average annual local white sugar price (constant \$/t) and contracts No. 5 and 11 (USD/t) during the period 1994-2017.

variable, with an average growth rate of 7.58%. Between 1994-2001 and 2002-2009, annual average rates were 12.56% and 15.44%, respectively (Figure 4). Growth was favoured by a higher international sugar price and also by the decision of the sector to export surpluses, thus preventing production peaks from having a negative impact on local white sugar price.

In the 2002-2009 period, local sugar consumption could not absorb total national production (more than 2 Mt),

so there was agreement to increase exports. The average volume exported was 442,076 t, and in 2009 the highest exported volume was recorded (808,296 t). At the end of the 2002-2009 period, the international sugar price began to rise, and this trend continued until 2012. This tendency was also observed in the local price of white sugar. Between 2010 and 2017, exports decreased by 2.41% on average per year, from 345,157 t to 291,000 t.

The production of bioethanol from sugarcane for

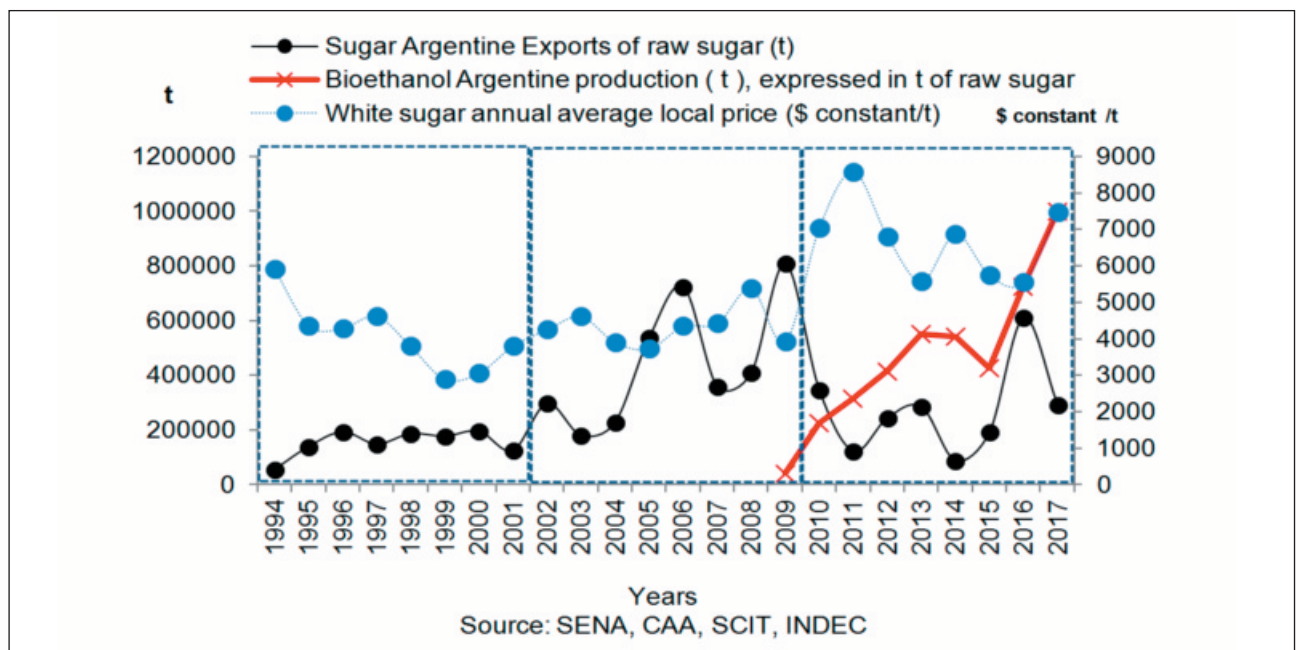


Figure 4. Local white sugar price (\$ constant/t), production of bioethanol from sugarcane in Argentina (t) and Argentina's sugar exports (t) during the period 1994-2017.

bioethanol-gasoline blends began in 2009, promoted by the government, which set the sugar industry as a priority (Pérez *et al.* 2011a). In the 2010-2017 period, ethanol production grew at an annual average rate of 23.7%. This compensated for the decline in exports and excessive sugar production for the domestic market, thus avoiding a decrease in local white sugar price (Figure 4).

Production costs and break-even point

Between 1994 and 2017, production, harvest and transport costs increased from 8,705 to 17,206 \$/ha (Argentine pesos at a constant value), growing at an annual average rate of 3.01% (Figure 5). Between 1994 and 2001 these costs diminished by 0.33%, but went up again between 2002-2009 and 2010-2017, growing at rates of 3.22% and 5.23%, respectively.

Throughout the 1994-2017 period, harvest and

transport costs represented more than 50% of the direct costs incurred per hectare, and grew at an annual rate of 1.23%, 2.69% and 6.50% in the 1994-2001, 2002-2009 and 2010-2017 periods, respectively.

Both ratoon cane costs (weed control and fertilization of 80% of the hectare) and plant-cane costs (deriving from cultural practices in the remaining 20% of the hectare) represented 20% of the total costs.

The break-even point is represented by the amount of sugar (expressed in tonnes per hectare) required to cover direct production expenses on one sugarcane hectare at a given price.

Between 1994 and 2017, the break-even point rose at an annual average rate of 1.89%. From 1994 to 2001, this indicator increased by 5.9% on average per year, and in the 2002-2009 and 2010-2017 periods it reached 4.45% and 4.34%, respectively (Figure 6).

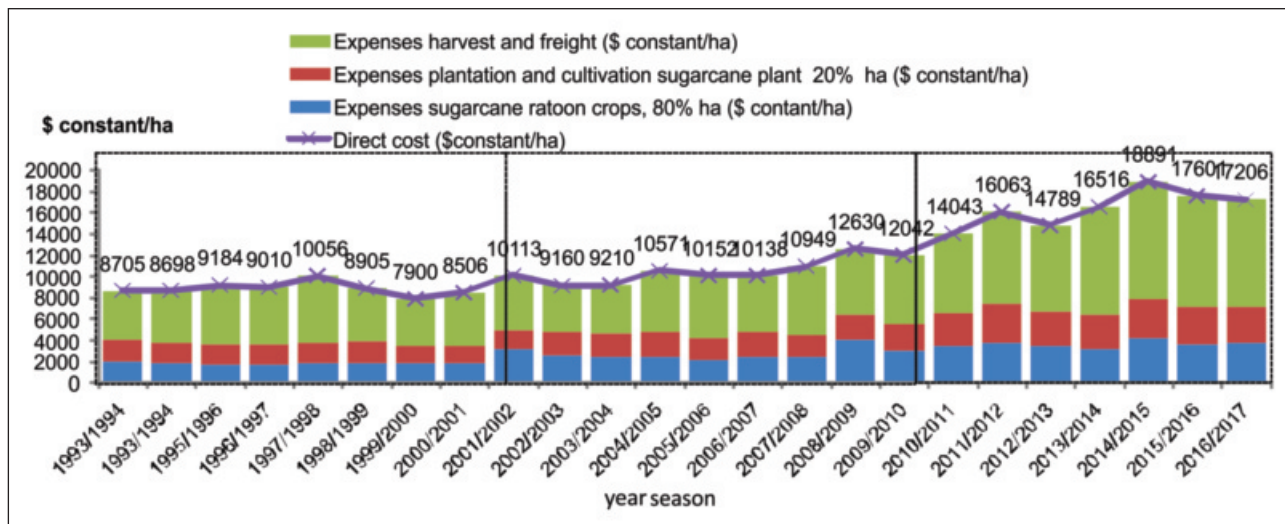


Figure 5. Expenses on sugarcane crop protection, planting, harvesting and transport (constant \$/ha) during the period 1994-2017.

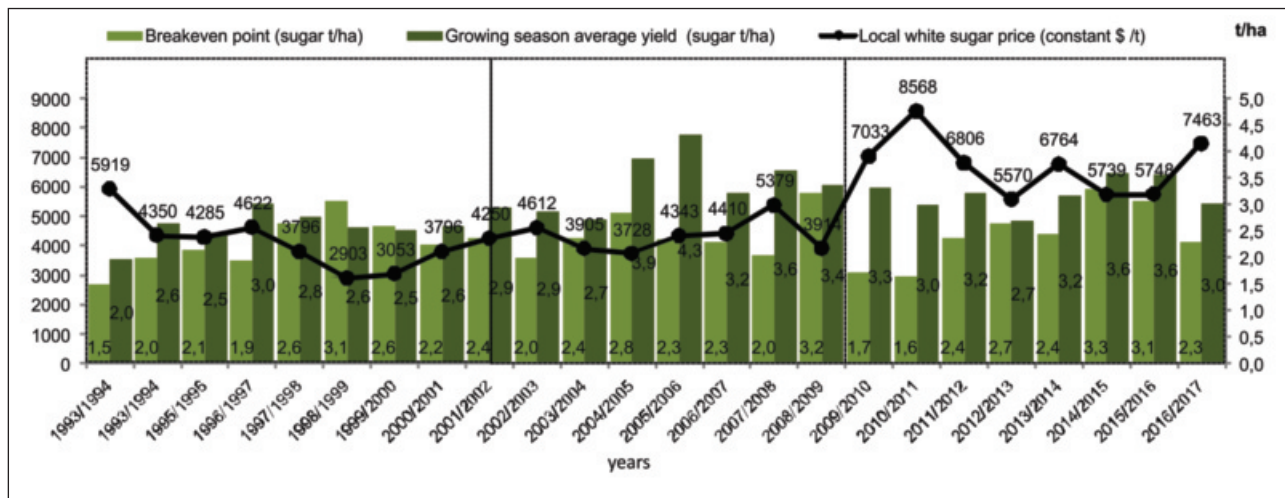


Figure 6. The break-even point expressed as sugar t/ha, average sugar yield (sugar t/ha), and domestic sugar price (constant \$/t) in Tucumán, during the period 1994-2017.

By matching the break-even point yield of one specific year to the average sugar yield recorded for the same year, it was possible to find out how profitable the crop was. The best period was 2002-2009, with a difference of 0.94 t/ha between these yields. During the 1994-2001 period, the difference was 0.30 t/ha, and during the 2010-2017 period, 0.76 t/ha (Figure 6).

Crop seasons 2004/2005 and 2005/2006 contrasted with seasons 2009/2010 and 2010/2011. In the 2004/2005 and 2005/2006 seasons (during the 2002-2009 period), there were occasions on which the difference between break-even point yield and average sugar yield was caused by high productivity. By contrast, during the 2009/2010 and 2010/2011 seasons (in the 2010-2017 period), the difference between yields was mainly due to a higher sugar price, which determined a lower yield for the break-even point (Figure 6).

During the 2010-2017 period, the mean difference between average sugar yields and break-even point yields in each season was 0.75 t/ha. In this later period, the difference between yields narrowed due to higher costs and lower productivity. A difference of 0.75 t/ha between average yields and break-even points in the crop seasons during the 2010-2017 period was equivalent to \$ 5,613/ha in legal tender of year 2017. In that year, the basic income for a family was \$19,328/month. Consequently, in 2017 a family needed an income of almost \$232,000 to cover yearly cost of living. This income was equivalent to profits obtained from 41.3 ha of sugarcane.

DISCUSSION AND CONCLUSIONS

In the 1994-2017 period, production, productivity (sugarcane yield, sugar recovery and sugar yield), local white sugar price, direct costs and break-even yield showed an annual average increase.

When analysing the sub-periods 1994-2001, 2002-2009, and 2010-2017, the best performance of the sugar industry in Tucumán was recorded between 2002 and 2009. In this period, record levels of sugar production, cane yield, sugar recovery and volume of sugar exported from Argentina were registered. This was also the period with the highest profitability, considering the average difference between sugar yield (t/ha) and the break-even point yield.

In the 2010-2017 period, the difference between the average sugar cane yield and the break-even point yield was reduced, due to a notable increase in costs and lower productivity. Profitably improved as a result of the higher price of white sugar in the local market which recorded a positive annual average growth rate, that was higher than that recorded in the 1994-2001 and 2002-2009 periods.

In the future, if productivity is not enhanced and costs increase, profitability will depend to a large extent on

price increases. For this reason, it was important to take consider the factors which determined productivity in the 2010-2017 period. Improved efficiencies in harvesting, transportation and planting make an important contribution to reducing costs and improving profitability. Careful planning and timing of the harvest and consideration of the distance between farms and sugar mills increases efficiency. Additionally, costs would be further reduced by the use of mechanical planting and implementation of practices that extend crop longevity and lower plant amortization.

The importance of considering derivative products that add value to sugarcane is emphasised, since bioethanol production plays a role in sustaining the price of sugar and counters the negative influence of an excess supply of sugar in the domestic market.

ACKNOWLEDGEMENTS

We thank agrochemical sales representatives, service providers, sugar mills employees and cane growers, as well as CAA, SCIT and INDEC, for the data provided.

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