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Inventories in the sugar market in Mexico

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ABSTRACT

Objective: To determine the minimum inventory which guarantees the domestic consumption supply and sugar exports in Mexico. The hypothesis was that an optimal inventory would lower storage costs and increase the sugar producers' income.

Methodology: To achieve the objective a spatial and temporal equilibrium model applied to the Mexican sugar market for the 2015 sugar cycle was formulated.

Results: The sugar industry in Mexico maintains an average monthly inventory of 831 thousand tons of sugar, a high inventory for most of the year. The inventory level could decrease to 416 thousand tons, given that this level guarantees the supply of the domestic demand and exports in the assessed year.

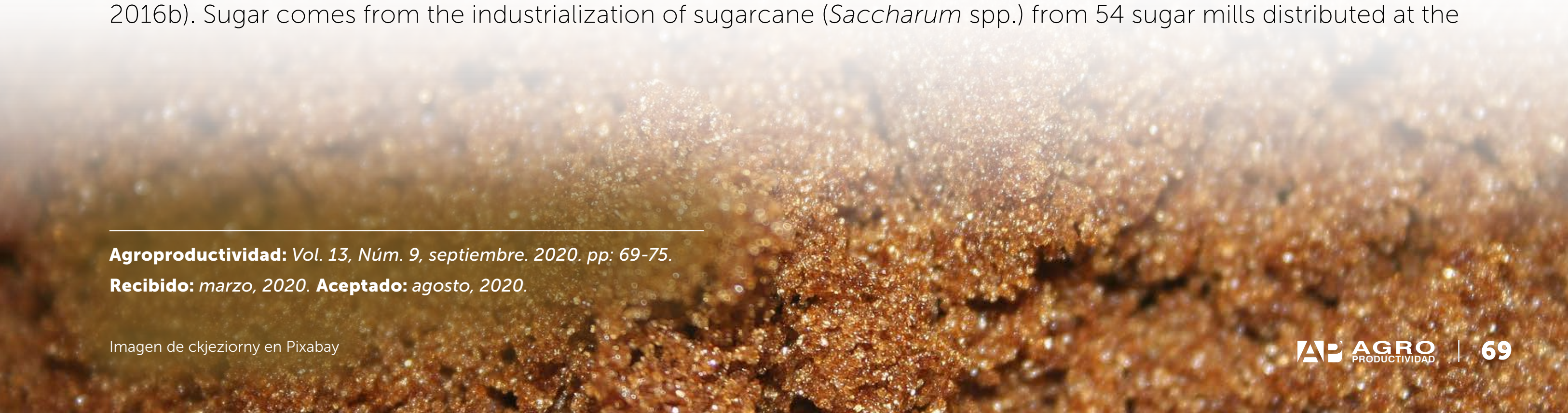
Implications: A management policy that keeps sugar inventories at their minimum level allows for a reduction of storage costs by 594 million pesos (MXN) and increases the income of the sugar producers by 635 million pesos (MXN).

Conclusions: Due to the positive effects on the producer's income, it is recommended that the sugar sector promotes a minimum inventory policy.

Keywords: supply, demand, exports, temporal, spatial equilibrium model.

INTRODUCTION

Sugar is used as a raw material for certain products, this determines that it is one of the most important energy foods in the agri-food sector in Mexico. During the sugar cycle from October 2014 to September 2015, the apparent national consumption of sugar in Mexico was 4.41 million t (CONADESUCA, 2016a). Between 2008 to 2013, the annual per capita consumption of sugar fluctuated between 40 and 50 kg, higher than that of other basic products such as beans, rice and wheat, and was only surpassed by corn (FAO, 2017). With an average factory yield of 11.16%, sugar production during the 2015 sugar cycle was 5.98 million t. 73.6% of the total production supplied domestic consumption, and 26.4% was exported to the United States (CONADESUCA, 2016b). Sugar comes from the industrialization of sugarcane (*Saccharum* spp.) from 54 sugar mills distributed at the



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Gulf, South, West, Northeast and Central Mexico (1 in Campeche, 1 in Colima, 2 in Chiapas, 6 in Jalisco, 3 in Michoacán, 2 in Nayarit, 3 in Oaxaca, 2 in Puebla, 1 in Quintana Roo, 4 in San Luis Potosí, 3 in Tabasco, 2 in Tamaulipas, 2 in Sinaloa, 2 in Morelos and 20 in Veracruz). During the 2015 sugar cycle, the harvested sugar cane area was 785 thousand ha, from which production of 53.68 million t was obtained (CEMA, 2016). As it depends on the biological and climatic conditions, the production of sugarcane and sugar is seasonal. The sugar cycle begins in October of one year and ends in September of the next, establishing months where sugar availability is reduced, and others such as January, February, March and April, where it is common that production exceeds a million t (CONADESUCA, 2016b).

The seasonality of sugar production determines temporary excess supply that generates price volatility. Part of the sugar production is sold during March, April and May, at prices that reflect temporary excess supply. In addition to these excesses, Mexican sugar prices are volatile due to the inelastic demand that characterizes this good. For Mexico, the price elasticity of sugar demand is −0.12 (FAPRI, 2016), which indicates that it is highly inelastic respect to the changes in its price. Data from the SNIIM (2016) indicate that between 2011 and 2016, wholesale prices at the Iztapalapa Central de Market, in Mexico City, had volatility with maximum prices of 718 pesos per 50 kg bag, more than double the minimum price, which was 310 pesos. These low prices are due to the sugar production seasonality, determined by the biological and climatic conditions that affect the production of sugarcane in the field. Apparently, the sugar industrial sector in Mexico has had no interest in influencing prices, suggesting a perfect competition market.

Due to the seasonality of the sugarcane production and the consumption uniform distribution, it is necessary to store and manage sugar inventories. Data from CONADESUCA (2016b) indicate that inventories at the beginning (October) of the 2013, 2014 and 2015 harvests were 966, 1,460 and 831 thousand t, and their final inventories (September) were 1,460, 831 and 810 thousand tons, respectively. If the initial inventory is compared with the average monthly domestic consumption of sugar (367 thousand t), the high difference raises the question of whether the management of sugar inventories is optimal.

Two approaches to inventory management can be distinguished: the "push" and the "pull" (Ballou, 2004). The push approach estimates the demand, and based on this forecast the required inventory to satisfy the demand is calculated; a company must forecast the quantity of product that will be required to produce and be sold. A disadvantage of the push approach is that sales and demand forecasts are often not accurate and may lead to unwanted inventory build-up and high storage costs; however, high inventories have the advantage of meeting any unexpected increases in demand.

The pull approach maintains a minimum inventory because a company only produces what is demanded. The advantage of this approach is the low storage cost due to minimal inventory. The disadvantage been the risk of not being able to supply an unexpected increase in demand. The Mexican sugar sector appears to practice a "Push" inventory control, which generates high storage costs. The high level of inventories seems to relate to the high sugar production, which in turn depends on the production of sugarcane, to the consumption decrease due to the substitution of this good for high fructose corn syrup, and to the restrictions to increase exports. Considering the importance of sugar, this research formulates a model that replicates the functioning of the sweetener market, determining the minimum inventory that allows the supply of consumption and exports for the 2015 sugar cycle. The research hypothesis assumes that a policy that guarantees a minimum inventory would reduce storage costs and increase the income of the sugar producers.

MATERIALS AND METHODS

A spatial and temporal equilibrium model was used to the sugar market for the 2015 sugar cycle that considers the production, consumption and exports of standard and refined sugar, the distribution of production, the supply of consumption and warehouse. The model formulation was based following García-Salazar and Skaggs (2015) and Borja-Bravo *et al.* (2013). Assuming i (i=1,2.. H=54) standard sugar mills, s (s=1,2.. S=54) refined sugar mills, j (j=1,2.. J=32) standard sugar markets, d (d=1,2..D=32) refined sugar markets, e(e=1,2...E =12) ports of exit for exports, and t (t=1,2..T=12) time periods, the model is:

$$
\begin{aligned}
MaxNSP = {} & \sum_{t=1}^{T}\pi^{t-1}\sum_{j=1}^{J}\left[\lambda_{jt}y_{jt}+\frac{1}{2}\omega_{jt}y_{jt}^{2}\right]+\sum_{t=1}^{T}\pi^{t-1}\sum_{d=1}^{D}\left[\lambda_{dt}y_{dt}+\frac{1}{2}\omega_{dt}y_{dt}^{2}\right]+\sum_{t=1}^{T}\pi^{t-1}\sum_{e=1}^{E}\left[p_{et}^{e}x_{et}^{e}\right] \\
& +\sum_{t=1}^{T}\pi^{t-1}\sum_{e=1}^{E}\left[p_{et}^{r}x_{rt}^{r}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{i=1}^{I}\left[v_{it}x_{it}+\frac{1}{2}\eta_{it}x_{it}^{2}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{s=1}^{S}\left[v_{st}x_{st}+\frac{1}{2}\eta_{st}x_{it}^{2}\right] \\
& -\sum_{t=1}^{T}\pi^{t-1}\sum_{i=1}^{I}\sum_{i=1}^{J}\left[p_{ijt}^{c}x_{ijt}^{c}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{i=1}^{I}\sum_{i=1}^{J}\left[p_{ijt}^{f}x_{ijt}^{f}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{i=1}^{I}\sum_{e=1}^{E}\left[p_{iet}^{c}x_{iet}^{c}\right] \\
& -\sum_{t=1}^{T}\pi^{t-1}\sum_{i=1}^{I}\sum_{e=1}^{E}\left[p_{iet}^{f}x_{iet}^{f}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{s=1}^{S}\sum_{d=1}^{D}\left[p_{sdt}^{c}x_{sdt}^{c}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{s=1}^{S}\sum_{d=1}^{D}\left[p_{sdt}^{f}x_{sdt}^{f}\right] \\
& -\sum_{t=1}^{T}\pi^{t-1}\sum_{s=1}^{S}\sum_{e=1}^{E}\left[p_{set}^{c}x_{set}^{c}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{s=1}^{S}\sum_{e=1}^{E}\left[p_{set}^{c}x_{set}^{c}\right] \\
& -\sum_{t=1}^{T}\pi^{t-1}\sum_{i=1}^{I}\left[p_{it,t+1}x_{it,t+1}\right]-\sum_{t=1}^{T}\pi^{t-1}\sum_{s=1}^{S}\left[p_{st,t+1}x_{st,t+1}\right]
\end{aligned}
\qquad 1)
$$

The target function is subjected to the following restrictions:

$$x_{it}+x_{it-1,t}-x_{it,t+1}\geq\sum_{j=1}^{J}\left[x_{ijt}^{c}\right]+\sum_{j=1}^{J}\left[x_{ijt}^{f}\right]+\sum_{e=1}^{E}\left[x_{iet}^{c}\right]+\sum_{e=1}^{E}\left[x_{iet}^{f}\right] \qquad 2)$$

$$x_{st}+x_{st-1,t}-x_{st,t+1}\geq\sum_{d=1}^{D}\left[x_{sdt}^{c}\right]+\sum_{d=1}^{D}\left[x_{sdt}^{f}\right]+\sum_{e=1}^{E}\left[x_{set}^{c}\right]+\sum_{e=1}^{E}\left[x_{set}^{f}\right] \qquad 3)$$

$$\sum_{i=1}^{I}\left[x_{ijt}^{c}\right]+\sum_{i=1}^{I}\left[x_{ijt}^{f}\right]\geq y_{it} \qquad 4)$$

$$\sum_{i=1}^{I}\left[x_{iet}^{c}\right]+\sum_{i=1}^{I}\left[x_{iet}^{f}\right]\geq x_{et}^{e} \qquad 5)$$

$$\sum_{s=1}^{S}\left[x_{sdt}^{c}\right]+\sum_{s=1}^{S}\left[x_{sdt}^{f}\right]\geq y_{dt} \qquad 6)$$

$$\sum_{s=1}^{S}\left[x_{set}^{c}\right]+\sum_{s=1}^{S}\left[x_{set}^{f}\right]\geq x_{et}^{r} \qquad 7)$$

$$\sum_{e=1}^{E}\left[x_{et}^{e}\right]=xa_{t} \qquad 8)$$

$$\sum_{e=1}^{E}\left[x_{et}^{r}\right]=xb_{t} \qquad 9)$$

$$\sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{t=1}^{T}\left[x_{ijt}^{f}\right]+\sum_{i=1}^{I}\sum_{e=1}^{E}\sum_{t=1}^{T}\left[x_{iet}^{f}\right]+\sum_{s=1}^{S}\sum_{d=1}^{D}\sum_{t=1}^{T}\left[x_{sdt}^{f}\right]+\sum_{s=1}^{S}\sum_{r=1}^{R}\sum_{t=1}^{T}\left[x_{srt}^{f}\right]=w \qquad 10)$$

$$\left[\sum_{t=1}^{T}\left[x_{et}^{e}\right]+\sum_{t=1}^{T}\left[x_{et}^{r}\right]\right]=q_{e} \qquad 11)$$

$$x_{i12,13}=x_{i0,1} \qquad 12)$$

$$x_{s12,13}=x_{s0,1} \qquad 13)$$

$$y_{jt},y_{jt},x_{it},x_{st},\ldots\ldots x_{st,t+1}\geq 0 \qquad 14)$$

Where for month t: $\pi^{t-1} = (1/1 + i_t)^{t-1}$ is the discount factor with i_t equal to the inflation rate; λ_{jt} and λ_{dt}, is the intercept of the standard and refined sugar demand function in j and d; y_{jt} and y_{dt} is the amount of sugar consumed in j and d; ω_{jt} and ω_{dt} is the slope of the demand function in j and d; $p^e_{et}, x^e_{et}, p^r_{et}$ and x^r_{et} is the international price and the exported quantity of the sugar per e; v_{it} and v_{st} is the intercept of the sugar supply function in i and s; x_{it} and x_{st} is the amount of produced sugar in i and s; η_{it} and η_{st} is the slope of the supply function for sugar at i and s; $p^c_{ijt}, x^c_{ijt}, p^f_{ijt}$ and x^f_{ijt} are the costs of transportation by truck and rail and the quantity of sugar shipped from i to j; $p^c_{iet}, x^c_{iet}, p^f_{iet}$ and x^f_{ijt} are the costs of transportation by truck and rail and the quantity of sugar shipped from i to e; $p^c_{sdt}, x^c_{sdt}, p^f_{sdt}$ and x^f_{sdt} are trucking and rail transportation costs and quantity of sugar shipped from s to d; $p^c_{set}, x^c_{set}, p^f_{set}$ and x^f_{set} are trucking and rail transportation costs and quantity of sugar shipped from s to e; $p_{it,t+1}, p_{st,t+1}, x_{it,t+1}$ and $x_{st,t+1}$ is the warehouse cost and the amount of sugar stored in i and s from t to t+1; xa_t and xb_t is the national quantity of exported sugar at t; w is the annual national shipment of sugar by rail; q_e is the exported quantity of sugar sent by e.

The target function maximizes the Net Social Payoff (NSP) and is equal to the area under the sugar demand curve, plus the value of exports, minus the area under the supply curves, minus the costs of transportation and storage. Constraints 2 and 3 indicate how sugar production is distributed. Constraints 4, 5, 6 and 7 indicate how consumption is supplied. Restrictions 8 and 9 indicate that the sum of sugar exports made by all ports of departure is equal to the observed monthly exports. Restriction 10 establishes a limit to mobilizations carried out by rail, and restriction 11 a limit to total sugar exports by port. Constraints 12 and 13 indicate that the final inventories are equal to the initial ones, and restriction 14 establishes the non-negativity conditions. The model considered all sugar consuming regions (31 states and Mexico City), 54 sugar mills and 12 exit points for exports. The minimum inventory scenario was defined as follows: a) First, the base model was set for the 2015 sugar cycle and; b) The assessed scenario consisted of reducing the initial inventory of standard and refined sugar, until a minimum that allowed the supply of the internal consumption and exports was determined for the cycle.

The model used monthly information for the 2015 sugar cycle. The supply and demand functions were calculated using the price elasticity, producer and consumer prices, and the quantities of sugar produced and consumed. The elasticities were taken from FAPRI (2016), sugar production by mill came from CONADESUCA (2016a), and the consumer price of sugar from SNIIM (2016). The producer price per mill was estimated by subtracting the cost of transportation from the consumer's price from each production area to the potential consuming regions. Sugar consumption was estimated as follows: a) The states monthly consumption of standard sugar was obtained by multiplying the monthly national consumption of standard sugar by the participation of each state in the population; b) The monthly state consumption of refined sugar was obtained by multiplying the monthly national consumption of refined sugar by the state's share of the value of the production of soft drinks and their biscuit industry. The assessed information came from CONADESUCA (2016a), INEGI (2014) and INEGI (2010).

The international price of sugar corresponds to the monthly average price of futures contracts, 11 listed in New York (CONADESUCA, 2016a). The information on the monthly exported quantity of sugar came from CONADESUCA (2016a). Exports distributed by port were obtained from SIAP (2016). To calculate the international price in pesos (MXN), the exchange rate was used (CONADESUCA, 2016a). The wholesale prices of sugar from SNIIM (2016) in the 32 cities of the country were used to derive the producer prices.

The transportation costs were calculated with a fixed factor and a variable one that depends on the distance (García-Salazar *et al*., 2005). Distance matrices were constructed from the mills to the markets and export ports. The fixed and variable factors for the railway came from the SCT (2016), for trucks were estimated. A function was used where transport costs and distance are the dependent and independent variables, the necessary information came from transport companies that trade sugar. The cost of storage considered the cost of entry and exit maneuvers and monthly insurance.

RESULTS AND DISCUSSION

The 2015 sugar cycle data indicate that production, consumption and exports were 5.985, 4.408 and 1.581

million tons, respectively. Out of the total production, 70.4% was standard sugar and the remaining 29.6% refined sugar. 75.3% of consumption corresponded to standard sugar and 24.7% to refined sugar. For exports, 38.9% was refined and 61.1% standard sugar (Table 1).

Sugar production was seasonal, 13.6% was obtained during December, 16.2% during January, 17.3% in February, 16.7% in March and 16.7% in April; in August and September there was no production. The sugar production seasonality relates to the sugar cycle, which depends on the sugarcane seasonality production. With a monthly average of 367 thousand tons, sugar consumption showed a slightly seasonal behavior, since the demand registered in December, February, March and April was greater than 10% of the total consumption; during each of these months, sugar production was greater than 800 thousand t. The average monthly exports were 132 thousand t, and the distribution throughout the year was not uniform, since 13.6, 14.1, and 11.0% of external sales were made during July, August and September, months which have low production.

Temporary oversupply is observed at the peak production months such as December, January, February, March and April. With a monthly average of 1.497 million tons, the inventory variation was variable throughout the year; November had the lowest level of production with 406 thousand t, and May the highest with 2.590 million t (Table 1).

To validate the base model, the observed inventories were compared with the estimated ones; small differences are observed between the two, barely 2.3% in November, hence, the base model can be used to carry out scenarios. The results of the model (Table 2) indicate that during the 2015 sugar cycle the economic surplus of the sugar market was 283,741 million pesos. Exports were valued at 12,502 million pesos, transportation costs from the production areas to the domestic markets and ports were 1,967 and 839 million pesos, while storage costs amounted to 2,128 million pesos. The NSP in the baseline scenario was 291,309 million pesos, and the consumption expenditure (for domestic sales) and producers' income were 40,735 and 48,303 million pesos.

Table 1. Sugar production, consumption, exports, and inventories during 2015. Thousands of tons.

Variable	ININ	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sept	Annual
Observed values from October 2014 to September 2015														
PSS		2	168	608	721	741	701	681	453	128	8	0	0	4,211
PRS		1	59	205	249	292	301	316	267	78	7	0	0	1,774
SSC		259	189	337	282	315	326	304	287	323	241	224	232	3,320
RSC		68	72	116	98	128	118	141	112	102	13	65	55	1,089
SSE		16	9	13	69	124	86	121	144	82	114	123	65	967
RSE		23	10	10	12	28	60	49	58	53	102	100	110	615
Estimated values with the shipments and reception of sugar obtained from the base model														
PSS		1	168	608	721	741	701	681	453	128	9	0	0	4,211
PRS		1	59	205	249	292	301	316	267	78	7	0	0	1,774
SSC		259	189	337	282	315	326	304	287	323	241	224	232	3,320
RSC		68	72	116	98	128	118	141	112	102	13	65	55	1,089
SSE		16	9	13	69	124	86	121	144	82	114	123	65	967
RSE		23	10	10	12	28	60	49	58	53	102	100	110	615
Observed inventory and estimated inventory with the base model														
Obs. Inv.	831	462	406	741	1,246	1,677	2,090	2,471	2,590	2,236	1,783	1,271	811	17,784
Est. Inv.	831	468	416	751	1,260	1,696	2,108	2,490	2,608	2,254	1,800	1,287	827	17,965
Dif. (%)	0	1.5	2.3	1.4	1.1	1.2	0.9	0.7	0.7	0.8	0.9	1.3	2.0	1.0
Inventories in the minimum inventory scenario														
Scenario	416	53	0	336	844	1,281	1,693	2,075	2,193	1,838	1,384	872	411	12,982

ININ=Initial inventory; PSS and PRS=Production of standard sugar and production of refined sugar; SSC and RSC=Standard sugar consumption and refined sugar consumption; SSE and RSE=Standard sugar exports and refined sugar exports.

Table 1 shows that initial inventories could decrease from 831 to 416 thousand t, guaranteeing the consumption and export supply. If the above happens, annual inventories (sum of monthly inventories) may decrease from 17.97 to 12.98 million t; the monthly average inventory would be 1.08 million t and would be zero during November. Its maximum value would occur during May with 2.19 million t.

The reduction of the inventories to the minimum would not affect the economic surplus, nor on the exportation value. Transportation costs to move the sugar production would decrease by 15 million pesos due to lower inventories which determine a lower availability of the product and, therefore, an adjustment in trade flows. Transportation costs to move sugar from the mills to ports would also decrease by 26 million pesos due to the changes that would take place in logistics. The cost of storage would decrease by 594 million pesos, increasing the producer's income by 635 million pesos. The net result of the scenario would be positive, since the inventories decrease to a minimum would improve the social welfare, due to the generation of more SNV, which would increase by 635 million pesos; an increase of 0.2%, compared to the base model.

Based on the above results, a policy that promotes the location of inventories at their minimum level is recommended. In the analyzed year, the level of observed inventories is high, reflecting unnecessary storage costs. Sugar producers will surely take better profits if they manage to reduce part of the unnecessary inventories to achieve a satisfactory supply of domestic consumption and exports.

CONCLUSIONS

The formulation of a spatial and temporal equilibrium model of the sugar market made it possible to determine a minimum inventory that would be required to supply both, domestic consumption, and exports of the sweetener for the 2015 sugar cycle. The inventory could decrease to 400 thousand tons and guarantee the supply; this would make it possible to considerably reduce the storage costs and improve the sugar producers' income.

REFERENCES

Ballou, R. H. (2004). Logística Administración de la Cadena de Suministro. 5ª ed. Pearson Educación. México, D. F., MEX. 789 p. https://ulisesmv1.files.wordpress.com/2015/08/logistica_administracion_de_la_cadena_de_suministro_5ta_edicion_-_ronald_h-_ballou.pdf

Borja-Bravo, M., J. A. García-Salazar and R. K. Skaggs. (2013). Mexican fresh tomato exports in the North American market: A case study of the effects of productivity on competitiveness. Canadian Journal of Plant Science 93:839-850. doi:10.4141/CJPS2012-108

CEMA (Compañía Editorial del Manual Azucarero S.A. de C.V.). (2016). Manual Azucarero Mexicano. 59ª ed. México, D. F., MEX. 495 p.

CONADESUCA (Comité Nacional para el Desarrollo Sustentable de la Caña de Azúcar. (2016ª). Información proporcionada en archivo electrónico por la Subdirección de Eficiencia Productiva y por la Subdirección de Comercio Internacional. Ciudad de México, México.

CONADESUCA (Comité Nacional para el Desarrollo Sustentable de la Caña de Azúcar). (2016b). Balance Nacional de Azúcar, Varios Meses. http://www.gob.mx/conadesuca

FAPRI (Food and Agricultural Policy Research Institute). (2016). Elasticities Databases. http://www.fapri.org/tools/elasticity.aspx

FAO (Food and Agriculture Organization of the United Nations). (2017). FAOSTAT-Food supply-crops primary equivalent. http://www.fao.org/faostat/en/#data/CC

García-Salazar, J.A., G.W.Williams, and J.E.J. Málaga. (2005). Efectos del TLCAN sobre Las exportaciones de tomate de México a

Table 2. Effects of a minimum inventory on the Mexican sugar market. Millions of pesos (MXN) and thousands of tons.

Scenario	ES	VE	IRTC	CTER	SC	NSP	CE	PI	INV
	Millions of pesos (MXN)								Thousands of tons
Base sit.	282,833	12,504	1,967	839	2,117	290,414	40,817	48,398	17,965
Base sit.†	283,741	12,502	1,967	839	2,128	291,309	40,735	48,303	17,965
Dif. (%)	0.3	0.0	0.0	0.0	0.5	0.3	-0.2	-0.2	0.0
Scenario	283,741	12,502	1,952	813	1,534	291,944	40,735	48,938	12,982
Change	0	0	−15	−26	−594	635	0	635	−4,983
Change in %	0.0	0.0	−0.8	−3.1	−27.9	0.2	0.0	1.3	−27.7

† Using estimated price. ES=Economic surplus; VE=Value of exports; IRTC=Internal route transportation costs; CTER=Cost of transportation of external routes; SC=Storage costs; NSV=Net Social Value; CE=Consumption expenses; PI=Producer's income; INV=Inventory.

los Estados Unidos. Revista Fitotecnia Mexicana. 28: 299-309. https://www.redalyc.org/articulo.oa?id=61028401

García-Salazar, J. A. and R. Skaggs. (2015). Strategies for white and yellow maize cultivar improvement research and technology transfer in Mexico. Agronomy Journal. 107:1425-1439. doi:10.2134/agronj14.0429

INEGI (Instituto Nacional de Estadística y Geografía). (2014). Censos Económicos 2014. https://www.inegi.org.mx/app/saic/

INEGI (Instituto Nacional de Estadística y Geografía. (2010). Censo de Población y Vivienda 2010. https://www.inegi.org.mx/programas/ccpv/2010/

SNIIM. (2016). Sistema Nacional de Información e Integración de Mercados. Mercados Nacionales Agrícolas. http://www.economia-sniim.gob.mx/Sniim-anANT/e_SelAzu.asp

SCT. (2016). Secretaría de Comunicaciones y Transporte.Tarifas Ferroviarias de Carga. http://www.sct.gob.mx/transporte-y-medicina-preventiva/transporte-ferroviario-y-multimodal/tarifas-ferroviarias-de-carga/

SIAP. 2016. Servicio de Información Agroalimentaria y Pesquera.Comercio Exterior. http://www.gob.mx/siap/acciones-y-programas/indicadores-economicos

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