



المجلة المصرية للاقتصاد الزراعي

ISSN: 2311-8547 (Online), 1110-6832 (print)

<https://meae.journals.ekb.eg/>

تحليل سلسلة القيمة لمحصول بنجر السكر في مصر مع التركيز على إنتاج السكر المكرر.

* شيماء سمير عبد الوهاب * أ.د سعد ذكي نصار * أ.د علية على الجندي ** د / فيكتور فارس شاكر *

* قسم الاقتصاد الزراعي - كلية الزراعة - جامعة القاهرة

** معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية

بيانات البحث

استلام 2022 / 9 / 11
قبول 2022 / 10 / 1

الكلمات المفتاحية
بنجر السكر؛
سلسلة القيمة؛
القيمة مضافة؛
الاقتصاد المصري.

المستخدم

يعد محصول بنجر السكر من أهم المحاصيل الاقتصادية لإنتاج السكر في مصر، حيث يمثل حوالي 62.1 % من إجمالي إنتاج محاصيل السكر. وفي ضوء الفجوة الراهنة بين الإنتاج المحلي والاستهلاك من السكر، تعتمد الدراسة الحالية على «تحليل سلسلة القيمة» لمحصول بنجر السكر لمساعدة صانعي القرار على تحديد مجالات التدخل الرامية في النهاية إلى تحقيق النمو الاقتصادي المستدام مع الحد من الفقر. ولتحقيق الهدف البحثي، تم الاعتماد على البيانات والإحصاءات الكمية التي أمكن التوصل إليها من الإحصاءات المنشورة وغير المنشورة خلال الفترة (2016-2020).

ولقد أشارت النتائج إلى أنه على الرغم من التحسن الكبير في إنتاجية بنجر السكر، إلا أنه لا يزال غير كافٍ لمواجهة النمو السكاني المتزايد إلى جانب التراجع في المساحة المزروعة. وتعزى التحديات التي تواجه إضافة القيمة على مستوى المزرعة إلى الارتفاع الكبير في تكاليف الإنتاج مقارنة بالإيرادات المتحصل عليها. ولقد أوضح تحليل سلسلة القيمة أن أعلى قيمة مضافة كانت على مستوى المزارع (33,4 %)، يليه المصنع (12,4 %)، وشركات التعبيئة (7,46 %)، وتاجر التجزئة (5,3 %)، ثم تاجر الجملة (5 %)، كما تبين أيضاً أنه كلما زادت القيمة التي يمكن أن يضيفها الجهات الفاعله "اللاعبين" إلى منتج ما، كلما زادت ربحيته. في هذا الإطار، توصي الدراسة بضرورة العمل على تطوير أصناف جديدة، وتحسين الممارسات الزراعية، وزيادة الاستثمار في التجهيز والتسويق، وتحسين تنسيق سلسلة القيمة، وتشجيع التعاون بين الأطراف المعنية.

وفيما يتعلق بالدراسات المستقبلية، هناك ضرورة لمواصلة العمل البحثي في تطوير سلسلة القيمة الحالية لتشمل المنتجات الثانوية الناتجة عن تصنيع السكر إلى جانب تقييم الآثار البيئية الناجمة.

الباحث المسؤول: د/ شيماء عبد الوهاب.

البريد الإلكتروني: shimaasamir955@gmail.com



Available Online at EKb Press
Egyptian Journal of Agricultural Economics ISSN: 2311-8547 (Online),
 1110-6832 (print)
<https://meae.journals.ekb.eg/>

Value Chain Analysis of Sugar beet in Egypt with a focus on the production of refined sugar

Shimaa Samir Abdelwahab Dr. Saad Zaki Nassar* Dr. Alia Ali Elgendi** Dr. Victor Shaker**

Department of Agricultural Economics, Faculty of Agriculture, Cairo University*
 Food Technology Research Institute, R.R.C **

ARTICLE INFO

Article History

Received: 11-9- 2022

Accepted: 1-10- 2022

Keywords:

sugar beet;

value chain;

value added;

Egyptian economy.

ABSTRACT

Abstract

sugar beet crop is one of the most Egyptian significant commercial crops for sugar production, representing around 62.1 percent of total sugar crop production. The current work adopts "value chain analysis" to understand the marketing system in its totality and to help decision-maker. The ties between the different phases of the value chain are governed by agreements and written contracts. Quantitative information was collected through consulting published statistics and administering a questionnaire within the period (2016–2020).

The findings point out that, despite the significant improvement in sugar beet productivity, it is still insufficient to meet the increasing population growth coupled with the decrease in the cultivated area. Additionally, the potential to add value at the farmer level is challenged due to the significant rise in production costs compared to revenue received at the farm gate. From the short review above, key findings emerge: the highest added value was the share of the producer (33.4 percent), followed by the factory (12.4 percent), packing companies (7.46 percent), and retailers (5.3 percent), and then the wholesaler (5 percent)..The more value an actor can add to a product for a given primary and intermediate cost configuration, the greater its profitability. To improve the value chain performance, the study suggests the following recommendations: developing new varieties, improving farming practices, increasing investment in processing and marketing, improving value chain coordination and encouraging collaboration among stakeholders. Further work is certainly required to explore the complete value chain including by-products as well as assessing its environmental repercussions.

Corresponding Author: shimaa Abdelwahab.

Email: shimaasamir955@gmail.com

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Introduction:

The sugar beet crop is one of the most substantial economic crops for producing sugar by extraction, which has a high nutritional value and is used in human food as a source of high energy. Sugar Beet cultivation also improves soil quality because it grows well in saline, newly reclaimed and calcareous lands. On the other hand, beet cultivation gives several career opportunities, both in the field and in sugar plants. It contributes approximately 1.42 million tons, accounting for approximately 62.1 percent of total production (2.28 million tons) in 2020, according to (MALR, 2021). Because of the difficulties and barriers in producing sugar from sugar cane, the importance of beet sugar in filling the sugar gap in Egypt has grown.

Egypt maintains consistent sugarcane production, while sugar beet production regions is expanding. The Foreign Agricultural Service (FAS) predicts that refined sugar production will rise by approximately 2.5 percent, or 70,000 tons, to 2.92 million metric tons in the marketing year 2022/23. Egypt's government stated that it had achieved 90 percent self-sufficiency in sugar production. In addition, it announced the formation of a new development project in New Delta to produce strategic commodities, as well as the allocation of 35,000 feddans (14,700 hectares) for sugar beet production (USDA, 2022). Weather conditions have a significant impact on sugar beet root yield and quality. The latter is crucial for economic sugar manufacturing (Asadi, 2007).

In all parts of the world, the modern retail revolution is reshaping the way food is produced, procured, and retailed. The whole value chain, including consumers, retailers, wholesalers, processors, and producers, is impacted by the quick changes in today's dynamic marketplaces. This has significant consequences for the competitiveness and long-term survival of small-scale producers. A value chain is a series of target-oriented combinations of manufacturing factors that, from initial conception to ultimate consumption, result in good or service. This covers tasks including design, production, marketing, distribution, and support services. (Coulibaly et al., 2010).

The activities that make up the value chain might be concentrated inside one firm or distributed across several firms, as well as concentrated in one place geographically or dispersed over a larger region. The concept of a "value chain" describes how the blending of various resources adds value to initial products (ILO, 2006). Written contracts and agreements govern the relationship between the various phases of the value chain.

The 2030 sustainable agricultural development strategy aims to raise the production of sugar to roughly 3.5 million tons by expanding the area planted with sugar beet to reach 800 thousand feddans by 2030 to address the sugar shortfall (Hashem, 2020).

Egypt suffers from a food gap in sugar due to the shortage of domestic production to meet consumer needs, which leads to the fluctuation of production and the continuous increase in the quantities consumed, which consequently exacerbates the instability of domestic prices (Diab et al., 2019).

The study seeks to identify the factors and variables influencing the technical and economic efficiency of sugar beet for Delta Sugar Company as a model for the entire industry, as it accounts for 20% of total production in 2022. Consequently, the broad conclusion can be drawn to boost the efficiency of the whole industry in Egypt. To achieve the study objective, a strategy tool, the value chain model, introduced by Porter in 1985, is used to analyze internal firm activities so that the source of cost or differentiation advantage can be recognized and improved. Further investigation is likely necessary to examine the whole value chain including by-products as well as examining its environmental consequences.

There are three parts to this paper. The first section outlines the literature review, and the second deals with the methodology adopted. The results are discussed in the third section. In the final part, some conclusions are drawn.

Literature Review

The literature review shows that there have been several studies to assess the technical, allocative, economic, and scale efficiencies of sugar beet as well as specify the significant economic variables associated with the production, consumption, and sugar industry in Egypt. Several approaches were employed to achieve the research objectives, most of which are the Date Envelopment Analysis (DEA), the linear programming model, the supply response model, and the Autoregressive Distributed Lag model (ARDL) (Table (1)).

Previous studies have emphasized the instability of sugar beet production. The money value of nitrogen fertilizers, human labor, and pesticides are the most influential determinants of its production. However, the sugar gap is influenced by per capita consumption of sugar, the population, and the total amount of sugar. The supply response model points out that farm price and area with a one-year lag are the most important factors affecting sugar supply from sugar beet. Using the ARDL model confirms the long-term relationship between sugar beet crop cultivated areas and production, previous farm price, and cost. Superior results confirmed that sugar beet was better than sugarcane in most indicators of productive and economic efficiency. Although there are many studies, the research in value chain analysis remains limited.

Methodology

The value chain is the interconnected series of value-creating activities that extends from basic raw material sources for component supply to the final end-use product or service provided to the customer (Drury, 2008). The value chain has a long history dating back to the 1960s, when French scientists established the filiere concept based on an investigation of the value-added process in US agricultural research. In the 1980s, Michael Porter was the first to use the terminology value chain. He defined the value chain as the different actions carried out at the chain's links (Figure 1). Gereffi established the notion of Global Commodity Chains in the mid-1990s (GCC) (Coulibaly et al., 2010).

Table 1. Summary of the selective relevant studies.

Author/s	Objectives	Methodology	Results
El-Feel et al. (2012).	Studying the economics and characteristics of sugar beet production through estimating the technical, allocative, economic, and scale efficiencies.	Date envelopment analysis (DEA)	<ul style="list-style-type: none"> - The estimated geometric mean for the instability coefficient of Egyptian sugar beet production amounts to 23.08 percent, which implies the instability of sugar beet production during the study period. - The determinants of sugar beet production in the sample farms were the money value of nitrogen fertilizer, organic fertilizer, human labor, and pesticides.
Hamada (2014).	Exploring the possibility of achieving efficiency and equity in sugar factories and sugar-cropping patterns in Upper and Middle Egypt.	The Linear Programming Model	<ul style="list-style-type: none"> - The cultivation season would lose 7.260 percent of its acreage as a result of an optimal cropping pattern, farm income would increase by 1.774 percent, water use would decrease by 18.5 percent, and CO2 emissions and energy use would be reduced by 14.96 percent. - Overall, Egyptian sugar exports would be reduced by \$130.086 million US due to an optimal sugar-cropping pattern.
Abd-Elrhman et al. (2015).	Specifying and analyzing some economic variables associated with the production, consumption, and sugar industry in Egypt.	Economic and efficiency indicators	<ul style="list-style-type: none"> - Economic indicators for sugar cane and sugar beet showed an increase in the profitability per Egyptian pound invested in the season by about 12.7 percent, as well as the measure of the ratio of total revenue to costs by about 5.6 percent. Efficiency indicators per unit of water show that sugar beet is higher than sugar cane by about 117.3 percent. - The most important factors affecting the sugar gap in Egypt are per capita consumption of sugar, the population, and the total amount of sugar.
Ahmed (2018).	Estimating supply response of sugar produced from sugar cane and sugar beet to reduce sugar imports.	Supply Response Model	<ul style="list-style-type: none"> - The farm price with a two-year lag and net return per feddan with a one-year lag are the two most important factors influencing sugar cane production. - Farm price and area, with a one-year lag, are the most important factors affecting sugar supply from sugar beet production.
Kandil and Gabr (2019)	Identifying sugar cane and sugar beet production in Egypt, as well as measuring the productive and economic efficiency of both crops.	Productive and Economic Efficiency Indicators	<ul style="list-style-type: none"> - The comparison between sugar cane and sugar beet showed that sugar beet was better than sugar cane in most indicators of productive and economic efficiency.
El-khalifa and Mohamed (2020)	Determining the most important variables that affect sugar beet crop cultivated areas in new lands in the long run	Autoregressive Distributed Lag model (ARDL)	<ul style="list-style-type: none"> - In the long run, there will be a relationship between cultivated areas of sugar beet crop and production, previous farm price, and cost.

Source: authors' compilation.

To evaluate added value and shares in trading, various types of information are required. Once the revenues and costs of each actor are determined, their financial positions can be calculated. The indicators adopted to analyze the value chain are as follows.

- Gross income = Revenue – Variable costs
- Gross margin = Gross income x 100 / Revenue
- Added value = Price received by actor – Price paid by actor
- Value share = Added value x 100 / Final retail price

Quantitative information was collected through consulting published statistics and administering a survey questionnaire within the period (2016-2020). Data was collected from the following sources: the Ministry of Agriculture and Land Reclamation (MALR), unpublished data from Delta Sugar Company, and existing studies of value chain analysis.

Results and Discussion

This section summarizes the findings and contributions made. It includes describing the main characteristics of the sugar sector in Egypt, the economics of sugar beet production, and the indicators of value chain analysis.

Sugar sector in Egypt

The major indicators describing the sugar subsector are encapsulated in Table (2). Sugar beet production increased by 2.98 percent per year from 1.3 million tons in 2016 to 1.3 million tons in 2020. The average production amounts to be 1.4 million tons during the period under study. It accounts for an average of 59.7 percent of total domestic production (2.3 million tons), fluctuating between 57.6 percent in 2016 and 62.2 percent in 2019.

Table 2. characteristics of the sugar sector in Egypt during the period (2016-2020).

Indicators	Unit	2016	2017	2018	2019	2020	Average	Growth rate (percent)
Beet sugar production	10 ³ Ton	1265.7	1325	1247	1528	1416.7	1356.5	2.98
Total sugar production	10 ³ Ton	2196	2249	2162	2458	2282	2269.4	0.98
Sugar beet share	%	57.6	58.9	57.7	62.2	62.1	59.7	1.95
Consumption	10 ³ Ton	3160	3230	3300	3375	3250	3263	0.71
Population	million	95.69	97.55	98.9	99.8	101.72	98.7	1.58
Consumption per capita	kg/year	34	34	34	34	32.5	33.7	-1.10
Gap	10 ³ Ton	964	981	1138	917	968	993.6	0.10
Self-sufficiency	%	69.5	69.6	65.5	72.8	70.2	69.5	0.25
Imports	10 ³ Ton	830	990	830	830	860	868	0.90

Source: Authors' calculations based on published data from the Ministry of agriculture and land reclamation.

Consumption increased from 3.2 million tons in 2016 to 3.3 million tons in 2020, with a 0.71 percent annual growth rate. The amount consumed amounted to approximately 3.3 million tons throughout the study period. It increased from about 3.16 million tons in 2016 to about 3.25 million tons in 2020, a 2.85 percent increase. However, per capita sugar consumption fluctuated from 34 kg in 2016 to 32.5 kg in 2020, representing a 1.10 percent annual decline during the period under study. The increase in sugar consumption is attributed to the steady increase in the population (1.58 percent annually), in addition to being involved in the manufacture of many commodities.

Sugar self-sufficiency fluctuates from 65.5 percent in 2018 to 72.8 percent in 2019, with an average of 69.5 percent during the review period. Imports increased from 830 million tons in 2016

to 860 million tons in 2020, with an annual growth rate of 0.90 percent to decrease the consumption gap, which totaled 993.6 million tons on average during the study period.

Economics of sugar beet production

Table (3) shows that the area planted for sugar beet crop decreased from approximately 555.6 thousand feddan in 2016 to approximately 518.3 thousand feddan in 2020, with a 1.68 percent annual reduction rate. The cultivated area amounts to 536.91 thousand feddan on average during the period under review.

On the other hand, the area supplied was about 545 thousand feddan in 2016, decreasing to 516 thousand feddan in 2020, recording about 529.42 thousand feddan on average, with an annual rate of about 1.33 percent. On average, it accounts for approximately 99 percent of total cultivated land.

Table (3) Cultivated and supplied area of sugar beet crop on sugar factories and Delta Sugar Factory during the period (2016-2020).

year	Cultivated Area (10 ³ feddan)	supplied area (10 ³ feddan)	Quantity supplied (10 ⁶ ton)	Yield (ton/ feddan)
2016	555.6	545.2	9.09	16.7
2017	526.1	511.6	9.10	17.8
2018	485.8	479.7	8.83	18.4
2019	598.8	594.2	10.98	18.5
2020	518.3	516.3	10.23	19.8
Average	536.91	529.42	9.65	18.2
Growth Rate (percent)	-1.68	-1.33	3.14	4.64

Source: Authors' calculations based on unpublished data from Delta Sugar Company.

The quantity supplied increased from 9.09 thousand tons in 2016 to 10.23 thousand tons in 2020, averaging 9.65 thousand tons with a 3.14 percent annual growth rate. During the period under study, It is also clear that there is a gradual improvement in productivity per feddan from 16.7 tons in 2016 to 19.8 tons in 2020, registering about 18.2 on average, with an annual growth rate of 4.64 percent during the period under review (Table (3)).

The operating cost estimated per feddan amounted to L.E. 9316.3, on average, for the period from 2018 to 2020 (Table (4)). Fixed costs account for 35.65 percent of total costs, while variable costs account for 64.35 percent.

Table (4) the operating cost per feddan for the sugar beet crop during the period (2018-2020).

Operation costs	2018	2019	2020	Average	Percent
Land Preparation	464	504	750	572.7	6.15
Seeds and planting	578	684	674	645.3	6.93
Irrigation	561	621	925	702.3	7.54
Fertilization	1286	1377	1293	1318.7	14.15
Weeding	394	292	595	427	4.58
Pest Control	514	652	698	621.3	6.67
Harvesting	621	693	912	742	7.96
Transportation	480	515	571	522	5.6
Other Expenses	392	427	513	444	4.77
Total variable costs	5290	5765	6931	5995.3	64.35
Rent	3323	3310	3330	3321	35.65
Total costs	8613	9075	10261	9316.3	100

Source: calculations based on published data from the Ministry of agriculture and land reclamation

A breakdown of the operating costs according to the relative weight in the total cost indicates that fertilizers come first, representing 14.15 percent, followed by harvesting (7.96 percent), irrigation (7.54 percent), seed and planting (6.93 percent), pest control (6.67 percent), land preparation (6.15 percent), transportation (5.6 percent), and weeding (4.58 percent). It is noteworthy 894

that a shortage of fertilizers in the Egyptian market leads some farmers to resort to the black market to acquire what they need for their land, leading to increasing prices.

The analysis of revenue from sugar beet production shows that the revenue per feddan increased from L.E 14.03 thousand in 2018 to approximately L.E 15 thousand in 2020, estimated by L.E 14.37 thousand on average, with an annual growth rate of 3.46 percent during the period (2018–2020) (Table (5)).

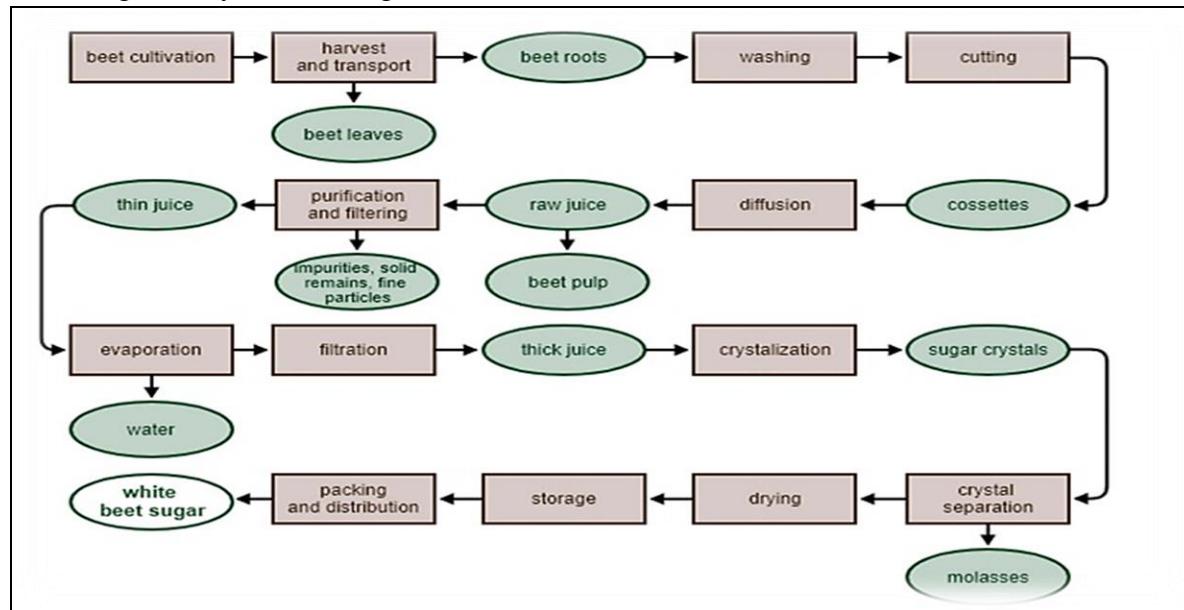
Table (5). The revenues per feddan of sugar beet during the period (2018-2020).

Item	Revenue (L.E)			Average	Growth Rate (percent)	Share (percent)
	2018	2019	2020			
Sugar beet	12721	12808	13508	13012.3	3.09	90.5
By-product	1306	1291	1489	1362	7.00	9.5
Total	14027	14099	14997	14374.3	3.46	100

Source Authors' calculations based on published data from the Ministry of agriculture and land reclamation

A breakdown of the revenue received according to its sources points out that 90.5 percent comes from the primary product and the remaining percentage pertains to the by-product.

After farmers harvesting, they are delivered to the factory pile grounds. Here, beets are dry screened, sampled, and weighed. The sugar beets are dumped into a wet hopper and floated into the factory. After passing through a catcher to remove debris, the beets are washed, rinsed, and fed into slicers. Here, very sharp knives cut them into long pieces called cossettes. The cossettes are fed into diffusion as sugar water called "raw juice". The juice enters the evaporators at 13 to 15 percent solids and leaves at 60 percent solids. It's called "thick juice." The thick juice is sent to a Metter where the raw sugars are dissolved through agitation and heat. This is fed into the white pen where white sugar is crystallized (Figure (1)).



Source: Tomaszewska et. al (2018)

Figure (1). Simplified scheme for beet sugar production

The solution is concentrated to 92 percent solids after crystallization and consists of sugar crystals surrounded by syrup. The crystals are separated from the syrup by spinning the sugar against a screen. The white sugar is conveyed to the granulator for further drying and cooling.

Value chain analysis

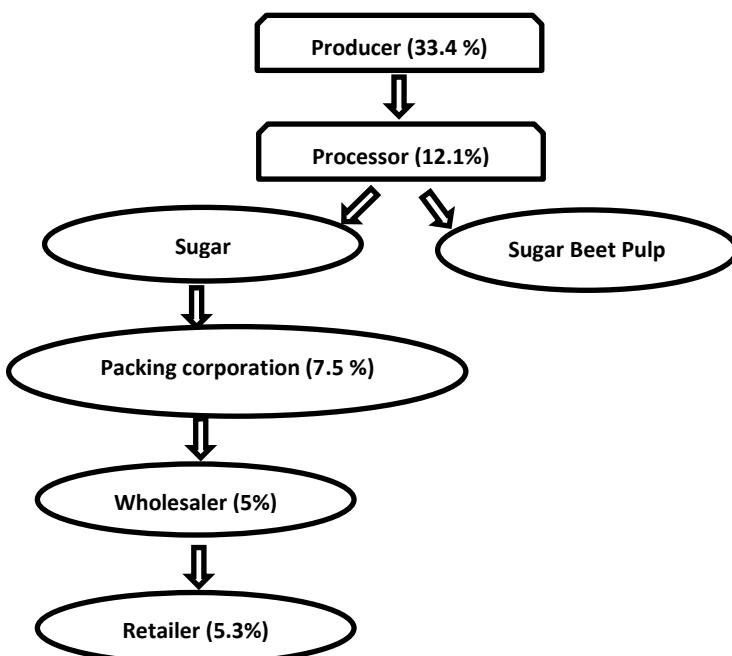
Based on the analysis, the value accumulation along the sugar beet value chain is illustrated in Table (6) and Figure (2). Given the technological level in the industry, seven tons of sugar beet will be required to produce a ton of sugar. The total production cost is estimated at L.E. 3802 (543.14/ton). In the domestic market, where sugar beet is directly sold to the processor via contract systems, the producer's revenue amounted to L.E. 4683 (L.E. 669/ton), making a gross margin of L.E. 881 (125.86/ton). The processor (factory) in turn sells the processed sugar to a packing corporation at L.E. 9535 per ton, which then sells to the wholesaler at L.E. 11432 per ton. The retailer receives a ton of sugar at L.E. 12832 and sells it to the final consumer at an average of L.E. 14030 per ton (L.E14/kg) at the time of conducting this study.

Table (6) Cost and Gross Margins for Sugar beet value chain actors.

Item	Producer*	processor	Packing Co.	Wholesaler	Retailer
Purchase price	-	7836	10385	12132	13282.5
Total cost	3802	8073	10525	12168	13291.7
Selling price	4683	9535	11432	12832	14030
Gross margin	881	1462	907	664	738.3
Gross margin percent	18.81	15.33	7.93	5.17	5.26
Value added	4683	1699	1047	700	747.5
value added percent	33.38	12.11	7.46	4.99	5.33

*Seven tons of sugar beet is processed to one ton of marketed sugar.

Source: calculations based on unpublished data from Delta Sugar Company



Source: Table (6)

Figure (2). sugar beet value chain actors & value added

The result indicates that the value of sugar beet increases by L.E. 10228 from the farm gate to retail markets. From the value accumulation data, the producer has the highest markup of L.E. 4683 (18.81 percent), while the processor gets L.E. 1462 (15.33 percent) and the packing corporation,

L.E 907 (7.93 percent). The wholesaler and retailer get L.E. 664 and L.E. 738.3, representing about 5.17 percent and 5.26 percent of the final retail price, respectively.

The producer comes first with a value-added of 33.4 percent, followed by the processor with a value-added of 12.4 percent. Following the processor are the packing company, retailer, and wholesaler, with respective value-added of 7.46 percent, 5.3 percent, and 5 percent. The more value an actor can add to a product for a given primary and intermediate cost configuration, the greater its profitability.

Conclusion

Value added is a measure of the value created in the economy. It is equivalent to the total value generated by the operators in the chain. Value added and productivity are useful measures to show whether an industry is competitive in its current operating and regulatory environment. The current work aims to analyze the value chain of sugar beet in Egypt to assess the chain's performance.

The findings indicate that the more value an actor can add to a product for a given primary and intermediate cost configuration, the greater its profitability. The producer has the highest value added (33.4 percent) and markup (18.81 percent), followed by the processor (12.4 percent) and (15.33 percent), the packing corporation (7.46 percent) and (7.93 percent), the retailer (5.33 percent) and (5.26 percent), and the wholesaler (4.99 percent) and (5.17 percent), respectively. The potential to add value to a product lies in an actor's ability to keep raw and intermediate input costs as low as possible and to increase the sale price.

Given these findings, collaboration is needed among policymakers, researchers, and practitioners; across different industry sectors; and among government, business, and civil society actors to develop and upgrade sugar beet value chain through achieving the following recommendations : developing new varieties, employing good production practices, increasing investment in processing and marketing, establishing a multi-stakeholder platform, and Improving the value chain coordination.

Future research should further develop and confirm these initial findings by extending the current value chain to include the by-products besides evaluating the environmental impacts.

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