

# SUGAR RUSH: PROSPECT FOR PAKISTAN ETHANOL MARKET

Ali Hassnain khan Khichi

## ABSTRACT

Agriculture is one of the main industries in Pakistan. It also accounts for 19% of the total GDP of Pakistan and it accounts for the 80% of the total earning of export (Agriculture department, 2020). 42.3% of the total labor force works in the agriculture industry. Since traditional energy resources such as fossil fuels, which are not renewable, and renewable biomass such as woods and agriculture trash, hence there is a quest for sustainable energy sources. Pakistan is the 5<sup>th</sup> largest sugar cane producer in the world, and 6<sup>th</sup> largest producer of sugar in the world (Psma, 2020). Therefore, sugarcane derived ethanol has great potential as future energy solution. Table 1 can confirm the data for Pakistan with regards to sugar cane cultivation, sugar production, molasses available and for the ethanol production. The data of current sugarcane, sugar and ethanol production was obtained from literature (Ali, Badar and Fatima, 2015). The forecast of sugarcane production up to year 2030 was obtained by ARIMA model for cotton and sugar cane in Pakistan. From this, sugar and ethanol production were calculated. This data was compared with projected sugar consumption as food and projected 10% ethanol blending with gasoline as a fuel (Ali Badar and Fatima, 2015). The highest sugar production was approximately 7 million MT in 2016-2017 from last few year and again fell down to 6.6 and 5.2 million MT in 2017-2018 and 2018-2019 respectively. Ethanol production is around 500,000-600,000 MT in last few years (PSMA, 2020). The sugar and ethanol production till date as well as projected through 2030 were found to be less by at least three times as food requirement and less than 20% ethanol blending as a fuel for automobile use, respectively (Ali, Badar and Fatima, 2015). Despite Pakistan is within top ten countries for sugarcane and sugar production, the current and projected sugar and sugarcane derived ethanol will not suffice the requirement. There is need to increase sugarcane production as well as setting up more ethanol distilleries in the country. This will require intervention at agriculture, technology, and better policies.

(Keywords: Automobile, ethanol, Pakistan, petroleum, sugar, sugarcane)

## INTRODUCTION

Pakistan is experiencing several social and economic problems due to energy crisis (Bhutto, Bazmi and Zahedi, 2011). More than 60% population economy in Pakistan is related to agriculture. In Pakistan, agriculture contributes about 19% of GDP (Ministry of Finance, 2019) and most of the population uses traditional biomass such as wood burning or agriculture trash

burning for cooking and household heating. Previously, Pakistan is using oil, gas, coal, hydroelectricity, and nuclear power as energy sources. Later on, due to excessive dependency on these fuels the country has to look for alternative energy sources. Pakistan Annual consumption of petrol is 7.6 Million MT and diesel is 7.3 Million MT per year (Ministry of finance, 2020). The liquid biofuels e.g. biodiesel and bioethanol are used for

transportation and electricity generation in developing industries. Utilization of ethanol as a biofuel will overcome the problems of non-renewability, greenhouse gas emission, high cost, the disadvantages associated with traditional fossil fuels. The modern bioenergy technologies such as ethanol refineries are crucial to utilize agricultural residues and to function as a supplementary role to meet the future energy requirements of Pakistan

(Naqvi et al, 2017).

The production of sugarcane was highest ever in 2016-2017. The total sugar production was 7 million and consumption was 5.2 Million, the consumption remained same for 2017-2018 and 2018-2019 but the production dropped from 2016-2017 and fell to 6.5 and 5.2 Million MT per year. The production of ethanol was approximately 600,000 MT and petrol consumption is 7 million approximately so total 700,000 MT of ethanol is required for 10% blending with petroleum as automobile fuel and can be seen in table 2. Pakistan ranks number 5<sup>th</sup> largest producer for sugarcane production in world. Despite of this, the demand for sugar is/will not be fulfilled. Ethanol will meet less than 10% blending capacity in future. Apart from this, there is demand for ethanol export to European, Far East and Middle East market. There is a need to increase the production of ethanol and it can be done by multiple ways such as more sugarcane production, integrated distilleries attached to sugar mills and able to use another feedstock which is equally available in Pakistan. Efforts are needed at agricultural, technology and government level to increase the sugarcane production by many folds to solve the requirement of food consumption, automobile fuel and export. If used as feedstock, sugar derived biofuels have the potential to uplift the rural population

above poverty in developing countries.

### **Sugarcane and sugar statistics in Pakistan**

Around 100 countries in word produce sugarcane. In 2019, the world sugarcane production was 179,700,000 MT per year (ISO, 2019). The major contribution of sugar production comes from Brazil, India, China, Thailand, and Pakistan (ISO, 2019). In Pakistan sugar industry is the second largest industry after textile (Hayat, Hussain and Yousuf, 2016). Pakistan is the 5<sup>th</sup> largest sugar cane producer in the world and 6<sup>th</sup> largest sugar producer and 7<sup>th</sup> largest consumer of sugar in the world (Iso Sugar, 2019). The sugarcane production is 62 tonnes/hectare in Pakistan (Psma, 2020). This is lower among the sugarcane producing countries such as Brazil and Peru where the average yield is 75 Mt per hectare. The reason for low yield is that the sugarcane growers are not following modern cultivation and harvesting practices (Bhutto, Bazmi and Zahedi, 2011) and lack of government interest to back up the industry with latest research on the seeds. The sugar production and consumption data for world's top 10 countries for the year 2017-18 is shown in Figure. Sugarcane production in Pakistan from the year 2012 to 2019 is shown in Figure.

### **Ethanol status in Pakistan**

Alcohol can be distilled from any plant matter (Hira, 2011). Ethanol is produced by

fermentation of hexose (sucrose, starch) present in sugar crops such sugarcane, sugar beet, wheat, and corn (Arshad, Abbas, and Iqbal, 2019). Amongst the number of crops such as maize, wheat, potato, and sugarcane being cultivated in Pakistan, sugarcane derived by-product (molasses) is the major feedstock for bioethanol production. Other crops are not used as feedstock for ethanol production due to food security issue, but it has to be noted that corn is grown for feed only in Pakistan and has nothing to do with food. If corn or feed grade wheat is converted to ethanol, it gives a valuable DDGS feed which is enriched with protein. The potential sugarcane derived ethanol producing zone around the equatorial belt consist of Brazil, Central America, the Caribbean, Northeast, South, and Southwest Africa, India, Pakistan, parts of Southeast Asia including Philippines, Thailand, and Vietnam. The biggest exporters for all types of ethanol are USA, Brazil, EU, Pakistan, China, and India. Pakistan's ethanol has excellent position in European, Far East and Middle East markets (Hayat, Hussain and Yousuf, 2016).

Production and export of sugarcane ethanol from Pakistan is shown in Figure. Obstacles for creation of new sugarcane derived ethanol production in developing world (Hira, 2011): Climatic conditions for sugarcane production.

Proper transportation and communication infrastructure. Good agricultural research. Farmer's education. Availability of cadre of managers. Organizing sugar industry to foster co-operation across supply chain for ethanol production. Dealing with greenhouse effects.

### Methodology

The forecast of sugarcane production and yield is obtained by using Autoregressive Integrated Moving Average (ARIMA) model. The predicted sugarcane production and yield are 71,414 MT per hectare, respectively, for the year 2030 (Ali, Badar and Fatima, 2015). Generally, 100-120 kg of sugar is produced from a ton of sugarcane. A ton of sugarcane produces 10% Sugar 4.5% of molasses and 1MT of ethanol can be produced from 4-5 Mt of Molasses. If the sugarcane is directly used for ethanol production, the yield is 70 liters per tonnes (Arshad, 2010). The cost of ethanol and petroleum in international market is taken as USD 1 and 0.71 per liter, respectively. The predicted values of petroleum consumption per year is obtained from the reference (harijan et al, 2009). The projected values of sugar consumption as a food are obtained from PPHS data of Pakistan for the year 2010 (Hayat, Hussain and Yousuf, 2016). The projected

data (presented in Error: Reference source not found of sugarcane, molasses, sugar, and ethanol, petroleum consumption, and cost of ethanol is shown graphically in Figure, Figure, and Figure.

### Data Analysis

#### Export

In 2017-2018, the sugarcane production was 83 MT, highest ever since crop production started. It was reduced to 67 MT in 2018-2019 (Psma, 2020). The sugar and ethanol production values are 6.5 MT and 550,000 MT, respectively, for the year 2017-2018 and 5.2 MT and 616,000 MT, respectively, for the year 2018- 2019 (Psma, 2020).

Since sugar is an essential food commodity, entire quantity of sugar is used for domestic consumption. Only the sugar-byproduct molasses is used for ethanol production. Bioethanol in Pakistan is produced totally from sugar molasses (Bhutto, *et al.*, 2011). There was a time when sugar industry used to throw the molasses in pits. But Advent of technology and creation of distilleries made it possible to earn Millions of USDs through export of ethanol from Pakistan. Ethanol export from Pakistan was 616,000 tonnes for the year 2018-2019 as against 550,000 tonnes for the year 2017-2018. This is highest ever since Pakistan entered world market in 2002-2003. In 2018, huge quantity of

ethanol was exported from Pakistan at the rate of USD 650/ton, fetching hefty amount of 450 M USD. Export from Pakistan will continue to dominate for ethanol in Asian market (Rana, 2019). If the sugar cane production in Pakistan remains between 65 million MT and 80 Million MT, with 85% utilization rate to make sugar, it will produce between 2.5 to 3 million MT of molasses, with molasses tax in place and if 95% is utilized to make ethanol, Pakistan will be able to produce 550,000-650,000 MT of Ethanol. If other feedstock or integrated distilleries are to be added this production can reach to 800,000 MT per year. This will result in ethanol export, and employability of farmers in Pakistan.

#### Ethanol blending

According to Ministry of finance (2020) Pakistan overall petrol consumption is 7.6 Million MT and from which only 30% is catered from local refineries and rest is being imported. Pakistan overall consumption per year is 7 million MT. Blending 10% of ethanol in petroleum would need 700,000 MT of ethanol. Pakistan has capacity to meet this annual demand of ethanol for fuel purposes by producing ethanol from sugarcane molasses. According to OGRA (2019) figures of oil purchase, it can save 64 million USD per year. If the population increases in near future for example by 10% in next 10 years, then Pakistan would need 770,000 MT of ethanol to blend if 7.7

million of petrol is needed per year. Blending the entire quantity of available ethanol will save approximately 63 Billion USD of foreign exchange.

Blending of 5% ethanol in gasoline does not require alteration of automobile engine. To utilize 10% ethanol blended fuel the automobile carburetor needs little adjustment. In future automobile industry should come up with engines which can utilize flexible proportion of ethanol in fuel.

This blending proportion needs to be increased in future for which a greater number of distilleries should be set up because currently distilleries are meeting the need of 5% ethanol blending with gasoline as automobile fuel (Bhutto, *et al.*, 2011).

The increased sugarcane yield and government policy to ban the export of molasses will increase the ethanol production from sugarcane (Bhutto, *et al.*, 2011).

Use of ethanol as a fuel in Pakistan has following advantages (Arshad, 2010) :

1. Reduced emissions: Ethanol contains oxygen. There is reduced CO and unburnt hydrocarbon emission from ethanol using as a fuel mix.
2. Reduced greenhouse gases: The net amount of CO<sub>2</sub> emitted from ethanol is zero. i.e. CO<sub>2</sub> emitted after ethanol consumption as fuel is equal to that of

the amount consumed during sugarcane plant growth.

3. Increased employment: 70% of the population is dependent on sugar industry in Pakistan. Few others are employed as skilled or semi-skilled laborers in sugarcane cultivation. Distilleries are another source of employment for people.
4. Pakistan is an agricultural country; therefore, it has huge potential for ethanol production from sugarcane. Bulk of sugarcane molasses is being exported yearly and only small amount of ethanol is produced from the molasses. This results in loss of foreign exchange and employment loss.
5. Ethanol has high heat of vaporization, high octanol number and low flame temperatures. This makes ethanol ideal for transportation.

### Electricity

The crop residues can be used in electrical energy generation by direct incineration methods. The limitation of the process is toxic emissions. For this purpose, biomass resource such as bagasse can be converted into biofuel like ethanol by microbial fermentation using Fischer-tropsch synthesis. This route is more energy intensive but here trace gas emissions are less (Kashif *et. Al*, 2020).

### Other uses of ethanol

Currently 18 distilleries attached to sugar mills are involved in production of three grades of ethanol, viz. anhydrous, extra neutral alcohol (ENA), and industrial ethanol (grade B). Apart from this, blend of ENA and grade B ethanol is also being produced (Rana, 2019). The anhydrous ethanol is used as fuel along with gasoline, ENA and grade B ethanol is used in making perfume and spirit (Rana, 2019). Major industries in which ethanol from Pakistan used are pharmaceuticals, air freshener, cosmetics, perfumes, personal care products, printing ink, vinegar, packaging, paints and varnish and chemical manufacturing (Hussain, Hayat and Yousuf, 2016).

### Sugar and ethanol production and demand

The demand for food consumption is always higher at least by more than three times the sugar production. In Pakistan crude oil prices and substitution elasticity is very high. It will produce more ethanol because industry is driven by pure profit motive without policy binding. Thus, there is a huge potential for ethanol market from sugar industry in Pakistan.

### Future Directions

The projected production of sugar and ethanol is less than that required for consumption. This is mainly because of less sugarcane production. The increase in per hector yield of sugarcane is possible by following modern agricultural

practices. Rural development, involvement of managerial cadre, and organization of sugar industry across ethanol supply chain are the key elements for harnessing maximum output from sugar ethanol.

Gasoline requirement and ethanol production potential in 2030 projected to be 5.75 MT and 1,017.4 million liters (Harijan, et al., 2009). Less than 20% ethanol blending with gasoline works well as automobile fuel. The projected ethanol production is less than that will be used as ethanol blended fuel (Hira, 2011). This will require creation of new distilleries to meet the growing demand of Ethanol in Pakistan.

Almost half of the imported petroleum is used for transportation industry. Therefore, there is need to lower the petroleum dependency of the country. Sugarcane derived ethanol is emerging as an alternative to reduce the burden on petroleum import. Automobile industry needs to invent vehicle engine in such a way that any proportion of ethanol and petroleum blend can be utilized by vehicles without any adjustment. Brazil model can be adopted to have a nationwide policies to make

10% ethanol blending mandatory and policies to force car manufactures industries to make such engines which can accept upto 20% ethanol blending with gasoline.

The prospectus of ethanol production from sugarcane molasses is being marred due to ignorance of policymakers and stakeholders. This is because companies get more margin in importing oil (Bhutto, et al., 2011). Government should provide favorable tax policy on sugar ethanol production leading to indirect subsidization vis a vis petroleum (Sahu, 2018). If policies are better and favorable, more private firms has more scope to invest in ethanol production from sugarcane molasses. Ethanol from sugarcane molasses can bring socioeconomic revolution in Pakistan due to income at farm, industrial and government level.

## CONCLUSION

In Pakistan, per capita energy consumption is increased by five folds over last six decades. This is due to growth of economy. There is energy crisis in the country.

Therefore, alternative energy resources are being discovered. Pakistan is an agrarian country and ranks 5<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> for sugarcane production, sugar production and sugar consumption.

In 2017-2018, the country has produced 550,000 MT of ethanol from sugarcane. Sugarcane derived ethanol from Pakistan has huge demand in EU, Far East and Middle East. Less than 10% ethanol can be blended with gasoline as a fuel without any adjustment in automobile engine. Other uses of ethanol are electricity generation and in chemical industries. By 2030, the requirement of ethanol is projected to be 10% Higher than what is now. For this purpose, ethanol production should be higher than current production rate. This dictates the setting up an additional distillery in the nation. Even though, Pakistan is amongst the top producer of sugar from sugarcane, there is unmet need of sugar and ethanol derived from sugarcane. Efforts are needed to increase the sugarcane production at agricultural, technology and government level.



## REFERENCES

- Agriculture Department (2020) Agriculture overview, Available at: <http://www.agripunjab.gov.pk/overview> (Accessed: 1st September 2020)
- Pakistan Sugar Mills Association (2020) Annual report 2019, [online] Available at: <https://www.psmacentre.com/documents/PSMAAnnualReportColorcopy2019.pdf> (Accessed: 1st April 2020)
- Ali, S., Badar, N., and Fatima, H. (2015) 'Forecasting Production and Yield of Sugarcane and Cotton Crops of Pakistan for 2013-2030', *Forecasting Production and Yield of Sugarcane and Cotton Crops of Pakistan for 2013-2030*, 31(1), pp. 1-10 [Online]. Available at: [https://www.researchgate.net/publication/306262520\\_Forecasting\\_Production\\_and\\_Yield\\_of\\_Sugarcane\\_and\\_Cotton\\_Crops\\_of\\_Pakistan\\_for\\_2013-2030](https://www.researchgate.net/publication/306262520_Forecasting_Production_and_Yield_of_Sugarcane_and_Cotton_Crops_of_Pakistan_for_2013-2030) (Accessed: 1st September 2020)
- Bhutto, A.W., Bazmi, A.A., and Zahedi, G. (2011) 'Greener energy: Issues and challenges for Pakistan--Biomass energy prospective', *Renewable and Sustainable Energy Reviews*, 15(6), pp. 3207-3219 [Online]. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S1364032111001523> (Accessed: 1st September 2020).
- Ministry of Finance (2019) Agriculture, Available at: [http://www.finance.gov.pk/survey/chapters\\_18/02-Agriculture.pdf](http://www.finance.gov.pk/survey/chapters_18/02-Agriculture.pdf) (Accessed: 2nd September 2020).
- Ministry of Finance (2020) Energy , Available at: [http://www.finance.gov.pk/survey/chapter\\_20/14\\_Energy.pdf](http://www.finance.gov.pk/survey/chapter_20/14_Energy.pdf) (Accessed: 2nd September 2020).
- Naqvi, S.R., Jamshed, S., Naqvi, M. and Farooq, W. (2017) Potential of biomass for bioenergy in Pakistan based on present case and future perspectives, Available at: [https://www.researchgate.net/publication/319873052\\_Potential\\_of\\_biomass\\_for\\_bioenergy\\_in\\_Pakistan\\_based\\_on\\_present\\_case\\_and\\_future\\_perspectives](https://www.researchgate.net/publication/319873052_Potential_of_biomass_for_bioenergy_in_Pakistan_based_on_present_case_and_future_perspectives) (Accessed: 2nd September 2020).
- ISO. (2019). About Sugar | International Sugar Organization. [online] Available at: <https://www.isosugar.org/sugarsector/sugar>.(Accessed: 30th March 2020)
- Hayat, N., Hussain, A. and Yousuf, H. (2016) Food Demand in Pakistan: Analysis and Projections, Available at: [https://www.researchgate.net/publication/293193514\\_Food\\_Demand\\_in\\_Pakistan\\_Analysis\\_and\\_Projections](https://www.researchgate.net/publication/293193514_Food_Demand_in_Pakistan_Analysis_and_Projections) (Accessed: 2nd September 2020).
- Hira, A. (2011) 'Sugar rush: Prospects for a global ethanol market', *Energy policy*, 39(11), pp. 6925-6935 [Online]. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0301421510004064> (Accessed: 1st September 2020).
- Arshad, M., Abbas, M. and Iqbal, M. (2019) 'Ethanol production from molasses: Environmental and socioeconomic prospects in Pakistan: Feasibility and economic analysis', *Environmental Technology & Innovation*, 14(), pp. 6925-6935 [Online]. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S2352186418301330> (Accessed: 1st September 2020).
- Arshad, M. (2010) A sustainable and environment friendly solution for Pakistan, Available at: [http://www.sciencevision.org.pk/BackIssues/Vol16\\_Vol17/03\\_Vol16\\_and\\_17\\_Bioethanol\\_MArshad.pdf](http://www.sciencevision.org.pk/BackIssues/Vol16_Vol17/03_Vol16_and_17_Bioethanol_MArshad.pdf) (Accessed: 2nd September 2020).

Harijan, K., Memon, M., Uqaili, M. and Mirza, U (2009) 'Potential contribution of ethanol fuel to the transport sector of Pakistan', *Renewable and Sustainable Energy Reviews*, 13(1), pp. 291-295 [Online]. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S1364032107001177> (Accessed: 1st August 2020)

Rana, P.I. (2019) Ethanol export fetches \$425m , Available at: <https://www.dawn.com/news/1458658> (Accessed: 1st August 2020).

OGRA (2019) Price Notification for Oil, Available at: [file:///C:/Users/Ali/AppData/Local/Temp/e\\_10\\_gasoline\\_price\\_notification\\_effective\\_dated\\_december\\_01\\_2019.pdf](file:///C:/Users/Ali/AppData/Local/Temp/e_10_gasoline_price_notification_effective_dated_december_01_2019.pdf) (Accessed: 1st August 2020).

Sahu, O. (2018) 'Assessment of sugarcane industry: Suitability for production, consumption, and utilization', *Annals of Agrarian Science*, 16(4), pp. 389-395 [Online]. Available at: <https://www.sciencedirect.com/science/article/pii/S151218871830068X> (Accessed: 1st August 2020).

## Tables

Table 1 Pakistan Sugarcane production, Sugarcane processed for sugar production and sugar recovery rate (Source: Author data taken from PSMA annual report 2019)

Table 2 Pakistan petrol consumption

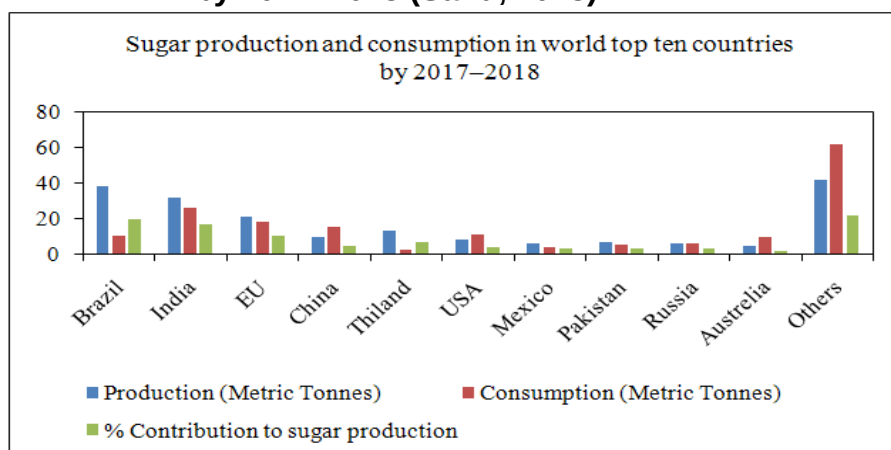
**Table 1**

	<b>Sugarcane production in Tonnes</b>	<b>Utilization % by Mills</b>	<b>Sugarcane processed for Sugar in Tonnes</b>	<b>Sugar production in Tonnes</b>	<b>Sugar recovery rate by %</b>
<b>2005-2006</b>	44,292,000	67.94	30,090,632	2,588,177	8.60
<b>2006-2007</b>	54,871,000	73.78	40,483,977	3,516,218	8.69
<b>2007-2008</b>	63,920,000	82.60	52,776,922	4,740,913	8.98
<b>2008-2009</b>	50,045,400	66.21	33,139,418	3,134,145	9.46
<b>2009-2010</b>	49,372,900	70.09	34,611,003	3,133,494	9.05
<b>2010-2011</b>	55,442,100	80.47	44,526,719	4,172,729	9.37
<b>2011-2012</b>	58,038,200	83.13	48,248,535	4,670,380	9.64
<b>2012-2013</b>	63,718,523	79.00	50,089,483	5,030,129	10.04
<b>2013-2014</b>	67,427,975	84.00	56,460,524	5,587,568	9.90
<b>2014-2015</b>	62,794,827	80.90	50,795,218	5,139,566	10.12
<b>2015-2016</b>	65,450,704	76.45	50,042,249	5,082,110	10.16
<b>2016-2017</b>	75,450,620	94.00	70,989,948	7,005,480	9.87
<b>2017-2018</b>	83,289,340	78.81	65,639,963	6,580,111	10.02
<b>2018-2019</b>	67,129,645	74.13	49,768,113	5,210,744	10.47
<b>2019-2020</b>	65,271,680	No data	No data	5,200,000 est	No data

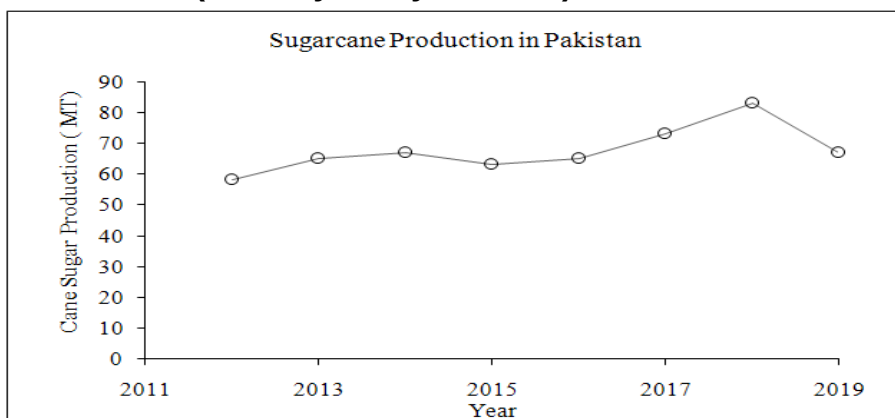
**Table 2**

<b>Pakistan Petrol consumption per year</b>	<b>7,000,000</b>
---	------------------

**Figure-1 Sugar production and consumption in world top ten countries by 2017–2018 (Sahu, 2018)**



**Figure-2 Sugarcane production in Pakistan from 2012 to 2019 (Industry-Analysis, 2019)**



**Figure-3 Production of sugarcane ethanol in Pakistan from 2010–18 (Arshad, et al., 2019)**

