

Sugarcane Production, Economics and Industry in Pakistan

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Abstract: Sugarcane is an annual crop belonging to genus *Saccharum*, family Poaceae and tribe Andropogoneae. It is cultivated in two seasons in Pakistan, during spring and autumn. Autumn crop gives fairly high sugarcane yield with more sugar recovery as compared to spring planted sugarcane. It is a crop which is produced in largest quantity worldwide. Total area under sugarcane crop in Pakistan during 2012-13 was 1.17 million hectares with total production of 66.5 million tons. The per hectare yield is much less in Pakistan that is 56 t ha⁻¹ as in 2012-13 as compared to other countries like Brazil, Egypt and USA. Pakistan produced 5 million tons of sugar with 24 kg of per capita sugar consumption in 2012-13, while in India it was 14 kg, Bangladesh 10 kg and China 11 kg. Pakistan is 9th largest sugar producer, 6th largest sugar producing country from sugarcane and 8th biggest consumer of sugar. Pakistan also produces huge quantity of molasses and those were 2.1 million tons in 2012-13, showing a bright export potential. Due to the rising costs of farm inputs particularly of fertilizers and irrigation from tube wells, the returns are decreasing as farmers can only earn a net income of Rs.39000 acre⁻¹ and that too after 12-14 months. There is a dire need to initiate an extension program to make the farmers aware of latest production technology and a breeding program to introduce new high yielding varieties that are pest-resistant too, to make sure sugarcane cultivation on sustainable basis.

Key words: Alcoholic beverages • Bagasse • Biofuel • Gur • Sugar • Molasses

INTRODUCTION

The demand of human being for sweet foods is universal. Honey was the main sweetener in primitive era. The trade in sugar from sugarcane is also of primitive time. In Pakistan, refined sugar is extracted by the sugar mills from three sources including sugarcane, sugar beet and raw sugar. Pakistan is the biggest consumer of sugar in South Asia with 24 kg capita⁻¹ year⁻¹ consumption, while in India it is 14 kg, Bangladesh 10 kg and China 11 kg. Sugarcane is the biggest source of sugar production in Pakistan. Sugarcane is any of several species of tall perennial true grasses of the genus *Saccharum*, tribe Andropogoneae and belongs to grass family Poaceae, an economically important seed plant family that includes maize, wheat, rice and sorghum and many forage crops. Sugarcane (*Saccharum officinarum*) has four other subspecies including, *Saccharum spontaneum*, *Saccharum sinensis*, *Saccharum baribrieri* and *Saccharum robustum*. It is native to the warm temperature to tropical regions of South Asia and used for sugar

production. Sugarcane is a stout jointed fibrous stalk that is rich in sugar and measured six meters tall. All sugarcane species interbreed and the major commercial cultivars are complex hybrid. The main product of sugarcane is sucrose, which accumulates in the stalk internodes. Sucrose is extracted and purified in specialized factories. Not only in Pakistan, but in the world, sugarcane is the largest crop by production quantity. Sugarcane is an important cash crop of Pakistan and plays an important role in the up lift of socioeconomic conditions of the growers. Rapid growth of sugar industry has contributed to economic development of the country. Sugarcane is the biggest source of revenue to the government because this crop fetches billions of rupees to the government in the form of duties and taxes. In recent industrial advancement sugarcane is not only confined to sugar production, but its bi-products form the basis of many important industries e.g. gur, molasses, alcohol, sugar beverages, chipboard, paper, confectionary and provide raw materials to many other industries such as chemical, plastic, synthetic fiber, insecticides and detergents. But on per

hectare basis, farmers in Pakistan are obtaining much less yield as compared to other countries and resultantly their economic returns decrease substantially. Even a slight reduction in sugarcane production negatively affects the working of sugar mills and less sugar is produced due to underutilization of sugar mills. In addition to low yield, ever increasing prices of farm inputs have further slashed farmer's margins.

This study provides an insight into prevalent agronomic practices for sugarcane cultivation, area, production, economics of cultivating sugarcane and causes behind poor performance of sugarcane in terms of cane yield on per hectare basis along with suggesting future needs and steps that need to be taken by farmers at micro level and policy makers at macro level. This study also provides an analysis of sugar industry in Pakistan and processing of sugarcane for sugar, Gur, molasses and other relevant products on commercial basis.

MATERIALS AND METHODS

In this study, the data pertaining to the cultivated area, production and yield of sugarcane were collected from Economic survey of Pakistan [1], Food and Agriculture Organization [2], Pakistan sugar mills association [3] and different related scientific articles. Interviews with farmers, wholesalers and retailers were conducted purposively during March 2013 to September 2013 in Faisalabad, Okara, Sahiwal and Pakpattan districts, to find ways for increased production of sugarcane on sustainable basis.

RESULTS AND DISCUSSION

FAO estimates sugarcane was cultivated on about 26.0 million hectares worldwide in 2012-13. It is grown in more than 90 countries, with worldwide harvest of 1.83

billion tons [2]. Brazil is the largest producer of sugarcane in the world. The next five major producers in descending order were India, china, Thailand, Pakistan and Mexico. Among 105 countries the World growing sugarcane, Pakistan rank 4th in area and 14th in production, 16th in yield and 8th in terms of sugar consumption in the world (Table 1) [1].

Botanical and Agronomic Aspects of Sugarcane:

Sugarcane is a cash crop but it is also used as a fodder for livestock. In Pakistan there are two planting seasons for sugarcane that are fall and spring. Fall planting starts from 1st week of September and continue till mid-October. Spring planting starts from mid-February and lasts until end of March. September planted (fall) crop usually produces 25-35% higher yield as compared to autumn planted sugarcane. Sugarcane is one of the most efficient photo synthesizers in the plant kingdom. It is a C_4 plant and is able to convert up to one percent of incident solar energy into biomass. Sugarcane is a perennial grass that forms lateral shoots at the base to produce multiple stems, typically 3-4 meters high and about 5 cm diameter. The stem grows into cane stalk which when mature constitutes approximately 75% of the entire plant. A mature stalk is typically composed of 11-16% fiber, 12-16% soluble sugar, 2-3% non-sugar, 63-73% water. It can produce over 15 kg of cane per square meter of sunshine. It requires plentiful supply of water for continuous period of more than 6-7 months each year, either from natural rainfall or through irrigation. The recommended number of irrigation is 26-33 for autumn crop and 21-26 for spring crop. Both plentiful water and sunshine increase cane production although sugarcane produce seeds, modern stem cutting has become the most common reproduction method. Seed rate is 8-9 tons of stripped cane hectare⁻¹ for thick varieties and 6-7 tons for medium varieties to produce desired plant population of

Table 1: World 10 top countries in terms of sugar production, consumption and cane sugar production (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

World 10 largest sugar producing countries (million metric tons)		World 10 largest sugar consuming countries (million metric tons)		World 10 largest cane sugar producing countries (million metric tons)	
Brazil	39.74	India	24.88	Brazil	39.74
India	29.19	EU-27	19.54	India	29.19
EU-27	18.31	China	15.34	China	11.89
China	12.99	Brazil	12.91	Thailand	10.37
Thailand	10.37	USA	10.34	Mexico	5.80
USA	8.17	Russia	5.65	Pakistan	5.13
Mexico	5.80	Indonesia	5.57	Australia	3.87
Russia	5.26	Pakistan	4.88	USA	3.56
Pakistan	5.15	Mexico	4.51	Indonesia	2.80
Australia	3.87	Egypt	3.19	Guatemala	2.71

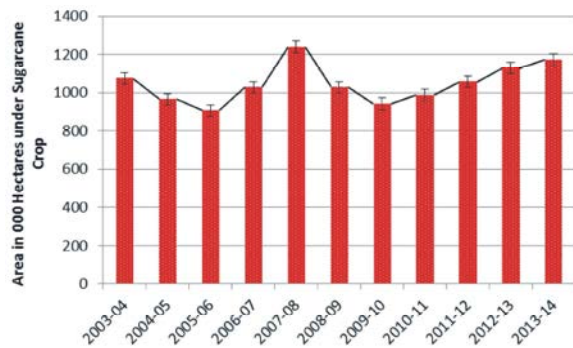


Fig. 1: Total area under sugarcane crop in Pakistan ((adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

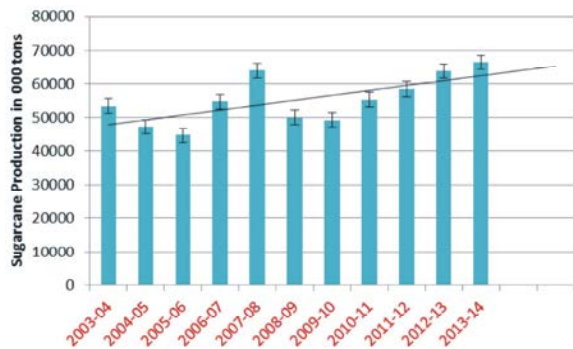


Fig. 2: Total production of sugarcane crop in Pakistan ((adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

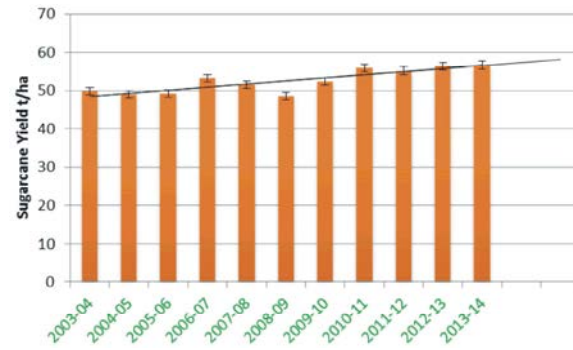


Fig. 3: Yield (t ha⁻¹) of sugarcane crop in Pakistan ((adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

about 0.15 million canes hectare⁻¹ [4]. A spacing of one meter between the rows for thick varieties and 0.60-0.75 m for medium varieties allows sufficient space for intercultural and earthing up operations. The most common methods of sugarcane planting are overlapping method, end to end method and double set method. Two budded double set should be selected for sowing in furrows and covered with 2-3 cm soil layer. Four bags of

urea, 2 bags of DAP and one bag of sulphate of potash are the minimum fertilizer requirement. The average yield of cane stalk is 56-60 tones hectare⁻¹ year⁻¹. Sugarcane harvesting is done by hand, which is labor intensive. On an average, one person can harvest 10,000 kg of cane in a day. The right time for harvesting is when the crop is 12-14 months old. The roots are left in the ground as they will eventually sprout and grow to form the next crop. After cutting, the cane is stripped, topped and bound in bundles of 10-15 kg for loading. Harvested cane should be sent to the sugar mills within 24-48 hours of harvesting, as late transportation results in sugar loss. Sugarcane crop is sensitive to the climate, soil type, irrigation, insect, disease, control varieties and harvest period. Some of the cultivated varieties are as follows: Cp.77-400, Cp-72-2086, SPSG-26, Th.10, CP.43-33, CPF-237, Mardan.92, Mardan.93, CP.65-357, NIA-98, NIA-2004, NIA, 2010 and NIA.2011 and Larkana-2004, HoTh-401, HoTh-409, HoTh-420, HoTh-432 and HoTh-438. In Punjab, it was found that overall HSF-240 was the leading variety followed by SPSG-79 and CPF-237 [5].

Sugarcane Varieties Capable of Fixing Atmospheric Nitrogen: Some sugarcane varieties are capable of fixing atmospheric nitrogen in association with the bacterium Gluco-acetobacter diazotrophicus, unlike legumes and other nitrogen fixing plants that form root nodules in the soil in association with bacteria, G. diazotrophicus lives within the intercellular spaces of sugarcane stem. Coating seeds with the bacteria is a newly developed technology than can enable every crop species to fix nitrogen for its own use.

Sugarcane Production in Pakistan: Sugarcane continues to remain one of the major crops of Pakistan. The area under sugarcane crop in 2003-04 was 1074 thousand hectares in Pakistan (Fig. 1). The highest area under sugarcane crop in last ten years was during 2007-08, when it was 1.3 million hectares and in 2013-14, total area under this crop was 1.2 million hectares [3], despite the fact that water availability for agricultural purposes is continuously on decline and farm input prices are on rise. Sugarcane production in 2003-04 was 43.4 million tons, while the maximum sugarcane production in country in last ten years was recorded during 2007-08 which was 63.9 million tons and in 2013-14, it reached to 66.5 million tons (Fig. 2). More production was probably due to better production technology adaptation by progressive farmers, but it was much less as compared to developed countries like Brazil and USA. Sugarcane yield in 2003-04 was 49.73 t ha⁻¹ and it reached to 56.66 t ha⁻¹ in 2013-14 [3]. Farmers have

Table 2: Economics of sugarcane production on per acre basis (as estimated in central Punjab)

Serial No.	Cost Incurring Items acre ⁻¹	Cost in Rs./acre
1.	Land preparation (Ploughing+ harrowing+ ridge making+ plotting)	2000+1800+600+400=4800
2.	Seed (setts) (2.5 tons)	2.5×4250=10625 (Rs.170/maund)
3.	Sowing (read as planting)	1000
4.	Fertilizers (3 urea bags+ 2 DAP bags)	8000
5.	Irrigations (70% canal irrigations excluding)	10000
6.	IPM	3000
7.	Harvesting (1000 kg/person/day)	8000
8.	Transportation	7000
9.	Other	5000
10.	Total expenditure	57425
11.	Gross income (yield 56 t ha ⁻¹)	567× 170=96390 (Rs.170/maund)
12.	Net income	96390-57425=38965

adopted modern production technology to some extent, but still per hectare yield is much less as compared to other sugarcane producing countries.

Sugarcane Price: The Provincial Government every year fixes indicative price of sugarcane before the start of the crushing season. For 2012-13 the sugarcane price was fixed at Rs.170 per 40 kg for Punjab and KPK and Rs.172 per 40 kg for Sindh.

Economics of Sugarcane Production: Despite the fact that Pakistan is endowed with optimum soil and environmental conditions that make possible of sugarcane cultivation in spring as well as autumn season, but matter of fact is that skyrocketing prices of inputs have decreased the margins of farming community, despite the increase in yield as well as better pricing regime. If a farmer owns his own land, then he is in a position to earn above Rs.39000 per acre (Table 2). To be realistic, this is a meager margin earned by a farmer after caring the sugarcane field for 12-14 months. The fact of matter is that rising prices of fertilizers and irrigation costs are responsible for increasing the cost of production. To make the matter even worse, farmers are deprived of timely payment of their dues by different sugar mills.

Snags in Sugarcane Production: Sugarcane production is a complex process and can be conceived as a function of several variables. The knowledge of the relative importance of the resource inputs which influence sugarcane production is essential for the sugarcane growers for introducing desirable changes in their operation at the micro level and for the policy makers for formulating plans for improvements in agricultural sector productivity based on sound economic principles at the macro level. Production practices such as, soil type,

planting time, varieties, inputs use and availability of irrigation water have a considerable impact on sugarcane production. The survey in different districts of Punjab such as Faisalabad, Okara, Sahiwal and Pakpattan highlighted several economical and technology related problems. The economic problems and constraints were lack of capital, high prices of input, low price of output and late payments of dues by sugar mills. All farmers said that high prices of inputs were a serious constraint in the course of sugarcane production. Procurement problems were other major problems for the growers in the study area. Lack of resources was also an important problem that the cane growers were facing, compounding the situation by low price of the output. Technical constraints were related to production techniques and technologies, such as lack of scientific knowledge, land preparation, seeds, pesticides and insecticides, inadequate irrigation and natural calamities, etc. Social problems were related to theft of sugarcane, cutting of tops as most of the farmers reported that the villagers were habituated to cut the tops of sugarcane for using it as cattle feed. Sugarcane is an attractive and tasty crop as people, especially the children are generally attracted to it. Chewing of cane was third social problems reported by sugarcane growers in the study area. Other reasons of low sugarcane production that were noted include, un-scientific or un-systematic agricultural practices, improper selection of land, improper preparation of land, conventional planting methods, late planting, moisture stress at critical stage of crop growth, poor management of ratoon crop, early and late harvest, environmental resistance, low soil fertility, particularly nitrogen which is required for vegetative growth of plants [6-10], defective varieties [11-15], un-controlled pest, disease and weed, variation in prices, unavailability of resources [16-20] for the growers, water logging and salinity.

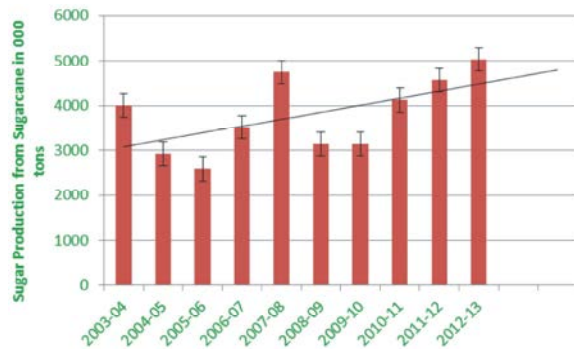


Fig. 4: Sugar production (thousand tons) from sugarcane in Pakistan ((adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

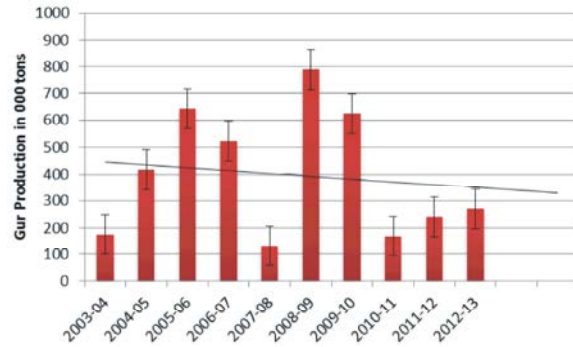


Fig. 7: Gur production (thousand tons) from sugarcane in Pakistan (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

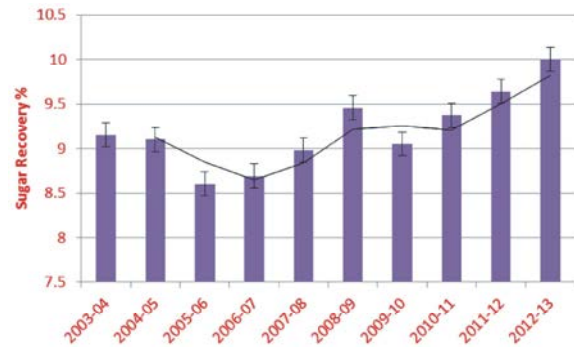


Fig. 5: Sugar recovery (%) from sugarcane in Pakistan ((adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

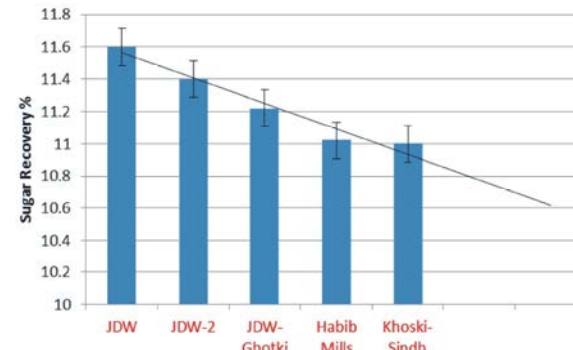


Fig. 8: Sugar recovery efficiency (%) of top five sugar mills of Pakistan (adapted from Pakistan sugar mill association (PSMA) annual report, 2013).

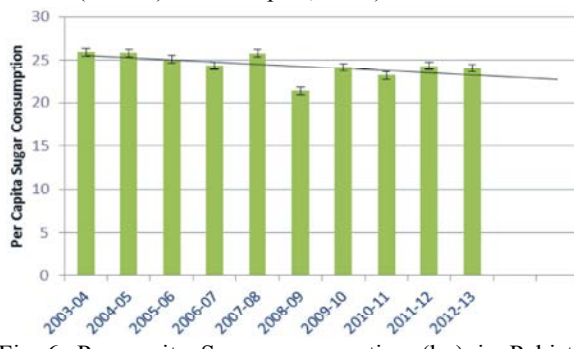


Fig. 6: Per capita Sugar consumption (kg) in Pakistan ((adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

Sugar Industry in Pakistan: In Pakistan about 90% sugar is extracted from sugarcane and 10% from sugar beet. In favorable years there is more sugar production than the requirement and in adverse years, the country fall short of sugar and thus resulting in importation. The sugar industry in Pakistan is the second largest agro – based industry, comprising 83 sugar mills with annual crushing capacity of over 6.1 million tones. These mills require

about 65 million tons of sugarcane to run in full capacity; however the sugar production is about 4 million tons on an average. Total sugar production in 2012-13 was 5030 thousand tons (Fig. 4) with sugar recovery percentage of 10 in 2012-13 (Fig. 5). This makes per capita sugar consumption of 24 kg in 2012-13 (Fig. 6). Gur making is also important in terms of sugarcane consumption and there was 270 thousand tons of gur production in 2012-13 in Pakistan (Fig.7). The production takes about 4-5 days after the harvest of sugar crop to off load the trolleys at mill gate. This leads not only to reduction in weight by about 2% but also affect the recovery of sugar by 0.1% each day. The top five sugar mills with most efficient technology to extract sugar juice are presented in Figure 8. Pakistan has losses about 5% sugars in producing bold crystal sugar to meet the consumer demand. Mill inefficiency is also one reason for low sugar production. The juice extraction efficiency of the mills stand around 90-92%, instead of 98%. Cane with trash as also affect the mill efficiency.

Processing, Milling and Refining of Sugar: Sugar production for manufactories involves three vital processes which are processing, milling and refining. Traditionally in sugarcane processing, sugar mills extract raw sugar from freshly harvested cane and mill-water sugar is sometimes produced immediately after the first stage at sugar extraction mill, intended for local consumption. Sugar crystals appear naturally in white color during the crystallization process. Sulfur dioxide is added to inhibit the formation of color inducing molecules as well as to stabilize the sugar juice during evaporation. Other products of processing include bagasse, molasses and filter cake. Bagasse the residual dry fiber of the cane after cane juice has been extracted and is useful for several purposes like fuel for the boiler and kiln, production of paper, paper board products, reconstituted plane board, agricultural mulch, a raw material for production of chemicals, dried filter cake for animal feed supplement, fertilizer and source of sugarcane wax. Molasses are produced in two forms, Blackstrap, which has characteristic strong flavor because of its vitamins and mineral content and pure molasses syrup. Blackstrap molasses is sold as a food and deity supplement. It is also common ingredient in animal feed, used to produce ethanol and rum and is used in the manufacturing of citric acid. Sugar refining further purifies the raw sugar.

Sugarcane Uses Other than Sugar Production: Sugarcane crop is able to efficiently fix solar energy and on an average, yields about 56 tons of dry matter per hectare of land annually. Sugarcane is processed and utilized to produce sugar juice and bagasse (fibrous dry matter after juice extraction). Bagasse has the potential as a abundant source of energy for large producers of sugarcane, such as Brazil, India and China. Brazil uses sugarcane to produce sugar and ethanol for gasoline and ethanol blends (gasohol), a locally transportation fuel. In India, sugarcane is used to produce sugar Jiggery and alcohol beverage. Ethanol is generally available as a byproduct of sugar production process which can be used as a biofuel. In Brazil gasoline is required to contain at least 22% bioethanol. The production of ethanol from sugarcane is more energy efficient than from corn, sugar beet or palm, particularly if bagasse is used to produce heat and power for the process. One hectare of sugarcane yields 4,000 liters of ethanol per year (without any additional energy input because the bagasse produced exceeds the amount needed to distil the final product). Bagasse is usually burned to produce steam, which in turn generates electricity. Modern technologies, as are used in Mauritius produce over 100 KWH of electricity

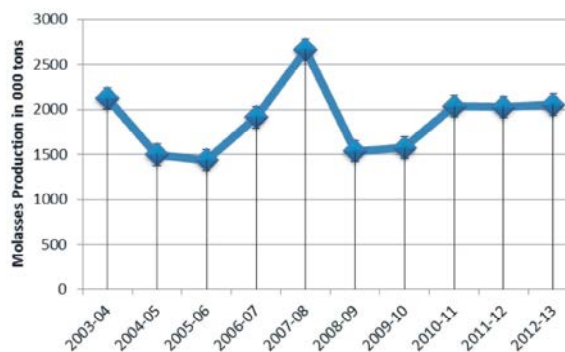


Fig. 9: Molasses production (thousand tons) from sugarcane in Pakistan (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

per ton of bagasse. With a total world harvest of 1 billion tons of sugarcane per year, the global energy potential from bagasse is over 100,000 GWH. Recent cogeneration technology plants are being designed to produce from 200 to over 300 KWH of electricity per tones of biogases. Technologies are being developed to use enzymes to transform bagasse into advanced biofuel and biogas. Sugarcane juice and molasses are used as sweetener and are used to make alcoholic beverages and candies. Pakistan produced 2 million tons of molasses in 2012-13 (Figure 9), which shows huge export potential.

Extension Program and a Variety Development Program:

Future Needs: There is a dire need of an extension program designed solely for sugarcane farmers in order to make them aware of latest production technology as well as other agronomic practices. Sugarcane yield per hectare is much less as compared to other countries and even we have failed to achieve the potential of prevalent varieties. This is because of lack of adoption of modern production technology for sugarcane production. Cane variety evolution work is carried out at the Government Research Institutes, established at Faisalabad (Punjab), Hyderabad, Thatta (Sindh) and Mardan (Khyber Pakhtunkhwa). Private sector (Shakarganj, Jhang) has also stepped in this work. Sugarcane Research Institutes in Pakistan have no cane breeding program of their own. Cane fuzz (true seed) of un-known characters is imported from various available resources like USA or Australia. Since supply of fuzz depends on donor country and un-assured funds availability, variety selection program is not consistent. Research institutions in public sector are mostly starved of funds and private sector is not much serious. So Government should focus on extension program by

providing funds, to bring the current production knowledge into access of farmers and to initiate a vast breeding program to secure the future of country in terms of sweetener production. Furthermore, only government can ensure timely payment of outstanding dues to farmers by sugar mills and this objective can be achieved through proper legislation. There should be such rules and regulation that bind the mill owners to clear the farmer's dues within a week or ten days. In addition to that, farmers should be given technical know-how by the sugar mills and this can be easily achieved, if sugar mills hire agriculture graduates and assign them the task to make aware the sugarcane farmers about the latest production technology. There is a need to enact laws regarding cane theft from the field and a comprehensive campaign must be launched through local newspapers, radio and television to make people aware of this unethical practice of cane theft for themselves or for livestock.

CONCLUSION

The sugarcane yield on per hectare basis is much low in Pakistan as compared to Brazil, USA and Egypt. Verities with poor yield potential along with unscientific cultivation and agronomic practices reduce the cane yield to a great extent. There is a dire need to initiate an extension program to make the farmers aware of latest production technology and a breeding program to introduce new high yielding varieties that are pest-resistant too, to make sure sugarcane cultivation on sustainable basis. Government as well as sugar mills should share the responsibility to make the farmers aware of modern production technology to achieve the full yield potential and for efficient utilization of precious resources, particularly the farm inputs such as fertilizers and water along with land resource base.

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