

Sugar Beet Potential to Beat Sugarcane as a Sugar Crop in Pakistan

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Abstract: Sugar beet (*Beta vulgaris* L.) is an herbaceous plant belonging to family *Chenopodiaceae*, also known as the goosefoot family. Sugar beet plant consists of three parts, namely crown, neck and root. The crown produces leaves and the root stores the sugar. About 30% of world sugar comes from sugar beet and Europe remains at top with regard to sugar beet cultivation as it provides 70% of the world sugar beet production. France is on top in terms of per hectare yield of sugar beet that is about 90 t ha⁻¹. Currently in Pakistan, sugar beet is being grown in Khyber Pakhtunkhwa (KPK) only and the area under sugar beet is continuously on decline from over 7000 hectares in 2004-05 to 1100 hectares in 2013-14 and yield has also witnessed a downward trend from 43 t ha⁻¹ in 2005-06 to a just 22 t ha⁻¹ in 2013-14, mainly due to lack of modern production technology, rising prices of farm inputs and marketing problems. Now only two out of four beet sugar mills are functional in Khyber Pakhtunkhwa, while other two has ceased to function due to the dearth of raw material. Economic analysis has revealed that sugar beet gives more monetary returns (Rs.9000) on per acre basis than sugarcane and that too in a short span of time. So this crop needs government attention in the wake of emerging water shortages to maintain sugar supplies in future by encouraging its cultivation in Punjab and Sindh provinces, because sugar beet has the potential to give 70 to 90 t ha⁻¹ yield with sucrose contents of 15-20%, much higher than sugarcane.

Key words: Goosefoot family • Fodder beet • Gur • Beet sugar • Sugary syrup

INTRODUCTION

Sugar in Pakistan is made from sugarcane and sugar beet, but sugarcane is the main and overwhelming raw material used for making sugar. Despite efforts to achieve self-sufficiency in sugar, with a network of 83 sugar mills, Pakistan remains a net importer of sugar which results in a huge financial liability on the national exchequer. Even with overriding efforts of sugar mills to acquire cane, cane supply for every sugar mill is low and as a result mills run underutilize along with low extraction rate due to deteriorated cane quality. Furthermore, the availability of agricultural water is continuously on decline which has made sugarcane cultivation in some areas, a difficult task. To encounter with increased demand of sugar, sugar beet, a lesser water demanding crop is an appropriate solution because it can produce almost two time higher sugar yield per hectare with less water and other inputs resources in

a short period of 5-6 months as compared to sugarcane that needs 12-14 months [1]. Sugar beet is the most important of several crops, including spinach beet, Swiss chard, garden beet (beet root) and fodder beet, within *Beta vulgaris* species [2]. It was selected from high sugar-content fodder beets at the end of the 18th century. Sugar beet was recognized as a plant with valuable sweetening properties in the early 1700s and used primarily for production of sucrose, a high energy pure food. Although beets have been grown as vegetables and fodder since antiquity, however, its use as a sugar crop is relatively recent. As early as in 1590, the French botanist Olivier de Serres extracted sweet syrup from beet root, but the practice was not widely used. Under the patronage of Frederick William III of Prussia, the world's first beet sugar factory in 1801 at Cunern in Silesia was made functional. By the beginning of the 19th century, beet was with approximately 5-6 percent sucrose as compared to around

20 percent in modern varieties [3]. Sugar beet (*Beta vulgaris* L.) ranks second most important sugar crops after sugar cane, producing annually about 30% of sugar production all over the world. Egypt has switched to sugar beet cultivation where there are newly reclaimed sandy soils and due to its tolerance to salinity and ability to produce high sugar yield under saline conditions and limited water requirements in comparison to the other traditional winter crops [4]. The sugar beet is particularly well adapted in irrigated agriculture [5]. Sugar beet has no self-regulatory mechanisms to promote sucrose accumulation but is dependent upon external stimuli from the climatic factors such as light, temperature and day length which determine to a great extent, the type of growth and the amount of sugar that gets stored in the root [6, 7]. Studies on sugar beet adaptability and nutrient management have been conducted in Peshawar valley and some other parts of the country [8-11] and to some extent on fodder beet in the salt-affected soils [12]. In Pakistan, sugar beet is grown and processed as an important cash and sugar crop of Khyber Pakhtunkhwa (KPK) [13]. It is considered to be an alternate sugar crop of the region. The crop has the peculiarity of giving as much yield per acre as that of sugar cane but with 20-25 percent higher recovery just in 6 months of crop season. Thus sugar beet ensures higher sugar production on per acre per month basis. But this crop, despite numerous advantages over sugarcane crop remains restricted in Khyber Pakhtunkhwa only and even in this province, area under this crop is continuously on decline and average yield is also reducing instead of rising. It represents a grim scenario as Punjab and Sindh provinces are quite suitable for sugar beet cultivation and area under this crop needs to be increased in the wake of emerging water shortages.

The present study provides an overview of agronomic and botanical aspects of sugar beet crop, economics of its cultivation along with future steps that needs to be taken for successful cultivation of sugar beet in other parts of Punjab and Sindh provinces of Pakistan to ensure continue sugar production even in the wake of emerging water shortage and climate change scenario and a comprehensive analysis of beet sugar industry in Khyber Pakhtunkhwa.

Botanical and Agronomic Aspects of Sugar Beet: Sugar beet (*Beta vulgaris* L.) is an herbaceous plant belonging to family *Chenopodiaceae*, also known as the goosefoot family. It is a biennial plant, completing its life cycle in two years. In its first year of growth, it develops a rosette of leaves and a large fleshy root, which stores the food

reserve in the form of sugar. If it is left to grow, in the second year, it produces flowers and seed. However, as a sugar crop, it is grown annually and efforts are made for the maximization of sugar deposition in the root. The plant consists of three parts, namely crown, neck and root. The crown produces leaves and the root stores the sugar [14]. The roots are cone-shaped ending in a slender tap form. The seed germination requires 5-10°C temperature, however high temperatures are preferred during vegetative growth. Sugar beet crop flourish best in loam and clay loam soils with a near neutral pH. Acidic conditions are unfavorable to its growth, however once established, sugar beet has a high tolerance against alkaline conditions. It has a fairly wide adaptability and is relatively resistant to cold, withstand drought and are not overly sensitive to salinity, however, productivity under unfavorable conditions is not high [15, 16]. Sugar beet is cultivated in Rabi season. October-November is considered an ideal month for sowing. The best planting time for Leiah, Bhakkar and Dera Ismail Khan Regions is from mid to end of the October. Varieties with higher beet root and sugar yield are Kave poly, Kave mira, Kave terma and Zwan poly and hybrid varieties though not widely cultivated such as SD-PAK04/06, SD-12970, SD-PAK09/07, SDPAK03/ 06, SD-PAK01/07, SD-PAK07/07, Mirabella, California, Magnolia, Ernestina and Sandrina [17]. Two times cultivation with cultivator and 1 deep ploughing is required for good seed germination. Seed rate is about 6-8 Kg/ha. Single row top seeding at 45 cm gives higher yield due to the higher plant population. Use of beet planter saves time, labor and gives higher economic efficiency over manual sowing. Besides flat sowing method, ridge plant is also an alternate technique. If seed bed is properly prepared and ridges are of equal height and leveled, then farmer can achieve better seed germination and better beet root formation. Sugar beet may be dibbled on top or both sides of the ridges depending upon ridge to ridge distance (45 or 75 cm). Plant to plant distance must be maintained up to 6-7 inches. Seed depth should be appropriate i.e. not more than 1 inch. This is because if seed is deeper then seed cannot germinate and there is a need to re-sow the seed. With regard to double row method, row to row space should be 75 cm; however, single row with top seeding at 45 cm gives higher yield. The ideal plant density is 87500 to 100000 per hectare. The optimum dose of fertilizers for sugar beet crop is, nitrogen @ 120 kg/ha, phosphorus (P_2O_5) @ 100 kg/ha and potash (K_2O) @ 62.5 kg/ha. First irrigation after sowing is very critical, because if field is over irrigated, it may compact the soil and seed

germination will be effected, so water should remain beneath the seed to moist it only. If irrigation is applied at right time, the crop growth is more vigorous, root formation is good and ultimately crop results a better yield. Farmers must be careful in irrigation prospective throughout the season especially at vegetative stage and root growth. Sugar beet is 6-7 months crop so it needs 8-10 irrigations. If soil is clayey then irrigation should be stopped 30-40 days before harvesting because this type of soil have more water holding capacity and crop does not face any stress. In other case, if soil is sandy then irrigation may be stopped 10-20 days before harvesting because sandy soil has lesser water holding capacity and crop may goes into water stress. There are very limited herbicides available in the market regarding beet crop. The experiments show that, the herbicide, Dual Gold has given good results in controlling weeds. It is a pre-emergence herbicide and can be applied in two different methods i.e. spray and flooded method. The most common diseases of this crop are Rhizomania, Cercospora leaf spot, Powdery Mildew and Downy Mildew. Rhizomania is a viral disease, while other three are fungal and bacterial diseases. Army worm is a major pest of sugar beet. When the leaves of the crop are yellowish green and reduce in size, it is the sign that crop is mature and ready to harvest. The best harvesting time is the month of May in the region of Laeiah, Bhakkar and Dera Ismael Khan. For easy harvesting, soil should be just moist but not too wet as it causes deterioration in root quality. Sugar beet spoils fast, it needs to be transported to the mill immediately [18, 19], so that it gets processed within 48 hours. Otherwise, yield and quality of sugar is adversely affected. Many varieties of sugar beet exist. Almost all are capable of giving yield of 30-90 tons or so per hectare with 10-20 % sugar content. Post-harvest staling is the most critical issue in beet harvesting. Both the growers and millers suffer from these losses. The weight losses in beet are 5, 10, 14 and 18 % on 2nd, 3rd, 4th and 5th day after harvesting respectively. Sugar recovery loss is recorded to the tune of 1.1, 2.4, 5.6 and 8.4 % respectively for the corresponding periods. It is recommended that beet should be transported and sliced within 24 hours of harvesting in the month of May. Losses may considerably be reduced by storing the beet under certain covers. Sugarcane can also be inter-cropped in sugar beet and sugar beet can also accommodate another kharif crop which is otherwise difficult in case of sugarcane. All forms of the species *B. vulgaris* are mainly cross-pollinated and intercross freely. In Pakistan, presently local seed production is not carried out because of higher cost and hence imported from Germany.

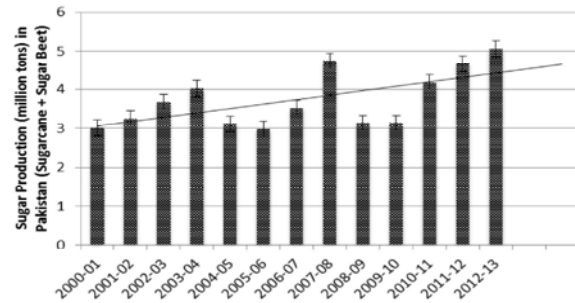


Fig. 1: Sugar production (million tons) in Pakistan from sugarcane and sugar beet Pakistan (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

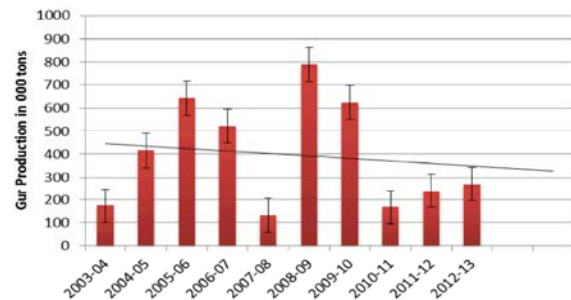


Fig. 2: Gur production (thousand tons) in Pakistan (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

Sugar Production in World and Pakistan: Currently sugar is produced in more than 100 countries and global production during 2013-14 has arrived at 181 million tons, while the consumption was 176 million tons and thus making a surplus of about 5 million tons worldwide [20]. Generally, the costs of producing sugar from sugarcane are lower than the sugar processed from sugar beet, because of absence of bagasse that is used to heat the boiler. The top ten countries with highest sugar production and consumption are listed in Table 1, which shows Brazil at the top, while Pakistan is at the 9th position among the highest sugar producing countries as Pakistan produces more than 5 million tons of sugar annually as shown in Fig. 1. India is world's biggest consumer of sugar and Pakistan is 8th biggest sugar consuming country in the world (Table 1). Pakistan produced about 5 million tons of sugar (Fig. 1), about 280000 tons of Gur from sugarcane (Fig. 2) and thus making per capita sugar consumption of around 24 kg (Fig. 3).

World Beet Sugar Industry: The experimental work in Germany laid the foundations of the beet sugar industry and the Napoleonic Wars gave the initial stimulus to its

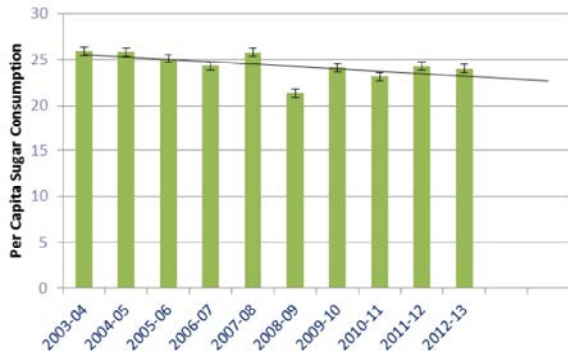


Fig. 3: Per capita Sugar consumption (kg) in Pakistan (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

Table 1: World top ten countries with the highest production and consumption of sugar (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)	
Brazil	39.74	India	24.88
India	29.19	EU-27	19.54
EU-27	18.31	China	15.34
China	12.99	Brazil	12.91
Thailand	10.37	USA	10.34
USA	8.17	Russia	5.65
Mexico	5.80	Indonesia	5.57
Russia	5.26	Pakistan	4.88
Pakistan	5.15	Mexico	4.51
Australia	3.87	Egypt	3.19

further development as an alternative to cane sugar, especially in France. The beet sugar industry in Europe rapidly developed after the Napoleonic Wars. In 1807, the British began a blockade of France. Blockade of continental ports during the Napoleonic wars, cut off the supply of sugar cane from the West Indies and favored the development of an alternative source of sugar and sugar beet was developed in Europe in the eighteenth century from white Silesian beet, then a fodder crop. By the end of the wars, over 300 sugar beet mills operated in France and central Europe. The first sugar beet mill in the U.S. opened in 1838 and the first commercially successful mill was established by E. H. Dyer in 1879. Sugar beet was not grown on a large scale in the United Kingdom until the mid-1920s. With various technical developments and favorable government policies, the beet sugar industry has expanded and the crop is cultivated and processed in Europe, North and South America, Asia and Africa. The total world sugar obtained from sugar beet is approximately 30% of the world sugar production [18]. Sugar beet is primarily a crop of the temperate region in Europe. However, advances in genetics and

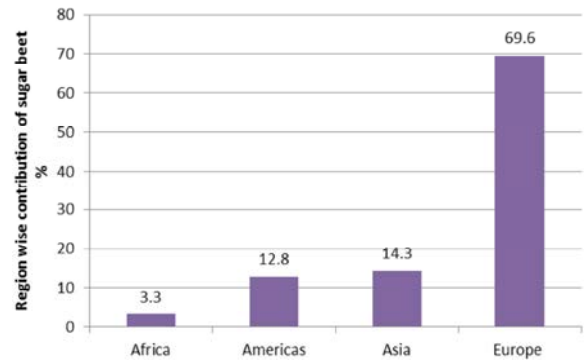


Fig. 4: Region-wise contribution in percentage of world's sugar beet adapted from FAO.

Table 2: Some Countries with yield of sugar beet ($t\ ha^{-1}$), adapted from FAO.

S. No	Country	Yield ($t\ ha^{-1}$)
1	France	193.8
2	USA	517.6
3	Germany	67.6
4	Russian Federation	32.3
5	Turkey	53.3
6	Poland	54.3
7	Ukraine	31.5
8	United Kingdom	70.0
9	China	38.5
10	Netherlands	78.9
11	Pakistan	40.4

Table 3: World's top ten countries with beet sugar production (adapted from Pakistan sugar mill association (PSMA) annual report, 2013)

Sr. #	Country	Beet sugar production (million metric tons)
1.	European Union	17.86
2.	Russia	5.26
3.	USA	4.60
4.	Ukraine	2.42
5.	Turkey	2.38
6.	China	1.10
7.	Egypt	1.10
8.	Iran	0.68
9.	Belarus	0.64
10.	Japan	0.60

agro-technological improvements have extended its scope to the subtropics where it is cultivated as an irrigated winter crop and consequently adequate percentage of world refined sugar comes from sugar beet. Now sugar beet is cultivated worldwide in more than 50 countries with 35,800,000 Mtrv (medium tactical vehicle replacement which is equal to 7 tons) beet sugar production worldwide in 2012-13 [20] and France is getting the highest yield of sugar beet of $94\ t\ ha^{-1}$ (Table 2), while Europe produces the highest sugar beet (Fig. 4) and European union also produces the highest beet sugar worldwide (Table 3).

Usages of Sugar Beet Other Than Making Sugar:

Molasses of sugar beet are a rich source of lactic acid and vitamins which are used widely in the alcohol, pharmaceuticals and baker’s yeast production. In some European countries, especially in the Czech Republic and Germany, sugar beet is also used to make rectified spirit. Sugar beets contain 10 to 20% sucrose. Sucrose is used widely as a pure high energy food or food additive. High fiber dietary food additives are manufactured from sugar beet pulp and major food processors in the United States use these dietary supplements in new products including breakfast cereals. The unrefined sugary syrup can be produced directly from sugar beet. This thick, dark syrup is produced by cooking sugar beet for several hours and then pressing sugar beet and concentrating the juice produced, until it has the consistency similar to that of honey. In Germany, particularly in the Rhineland area, this sugar beet syrup (called Zuckerrüben-Sirup in German) is used as a spread for sandwiches, as well as for sweetening sauces, cakes and desserts. Sugar beet pulp and molasses are widely used as feed supplements for livestock. These products provide required stuff in rations and increase the deliciousness of feeds. In addition to beet root, the main produce, sugar beet crop produces about 5-10 tons of beet tops. Tops are an excellent source of protein, vitamin A and carbohydrates but are slightly inferior to alfalfa or corn silage. Beet top silage is best feed in combination with other feeds. These can be used as feed for milch cattle. However, because of the presence of oxalic acid in the freshly harvested material, mixing of finely ground lime @ 60g/100 kg top is recommended. The tops are also useful as green manure. Tops from one hectare add about 100 kg nitrogen to soil. Left over lime from the processing of sugar beets is an excellent soil improvement material. Waste lime is a good source of P and K plant nutrients.

Sugar Beet Cultivation in Pakistan: In Pakistan, Khyber Pakhtunkhwa has the privilege to grow sugarcane and sugar beet in the same field simultaneously since the mid-sixties. Sindh is the only other province where sugar beet is cultivated on a very stunted scale ranging between 50 to 100 hectares, while the initial technical evolution shows that agronomy wise, sugar beet can be grown as a winter crop, both in lower Sindh and Punjab, to be sown in October/November and harvested in April/ May after the cane crushing is over. Pakistan needs to increase sugar production from sugar beet in wake of serious water shortages in the country. While, the entire country is suitable for the cultivation of sugar-beet by replacing

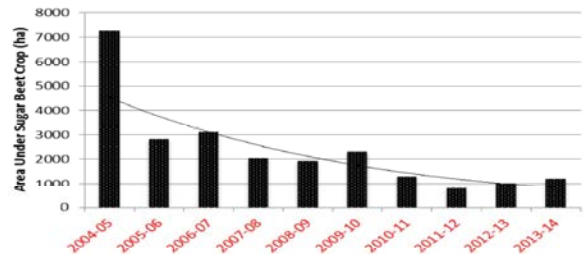


Fig. 5: Area (hectares) under sugar beet crop in Pakistan, adapted from FAO.

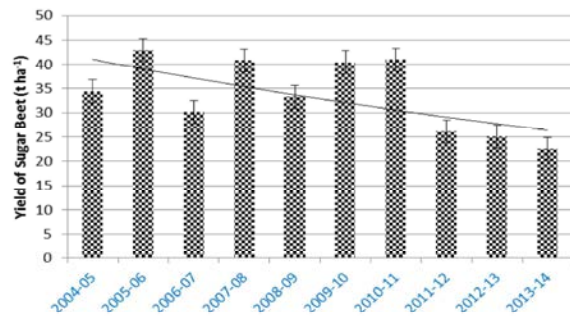


Fig. 6: Yield of sugar beet (t ha⁻¹) in Pakistan adapted from FAO.

sugarcane the climatic conditions of lower Sindh and some parts of Punjab are particularly favorable to the crop - conditions similar to Nile delta valley of Egypt, where commercial sugar beet production has been successful for many years, all the other kharif Crops are not replaceable, but sugarcane could easily be replaced with sugar beet, which would help maximization of land use and consumes less water as compared to sugarcane [18, 19]. The area under sugar beet crop in 2004-05 was more than 7000 hectares which is continuously on decline and in 2013-14, it was only 1100 hectares (Figure 5) with yield of about 22 t ha⁻¹ (Figure 6), mainly due to lack of modern production technology, rising prices of farm inputs and marketing problems.

Economics of Sugarcane and Sugar Beet Production:

Economic analysis of sugar beet (Table 4) and sugarcane (Table 5) shows that sugar beet gives more returns than sugarcane and that too in a short period of time of 5-6 months as compared to sugarcane which takes 12-14 month. The significantly less investment is required for sugar beet cultivation as compared to sugarcane and comparatively more monetary returns are earned in the range of 9-10 thousands on per acre basis. It is also revealed that land preparation and irrigation costs along with fertilizers are the real heads that consume majority of

Table 4: Economics of sugar beet production on per acre basis

Serial No.	Cost Incurring Items acre ⁻¹	Cost in Rs. acre ⁻¹
1.	Land preparation (Ploughing+ harrowing+ ridge making+ plotting)	2000+1800+600+400=4800
2.	Seed (2 kg)	1000×2=2000
3.	Sowing (2 men/day)	8×250=2000
4.	Fertilizers (2 urea bags+ 2 DAP bags)	3200+3200=6400
5.	Irrigations (70% canals excluding)	1600×4=6400
6.	IPM (weedicide+ insecticide)	1500+1500=3000
7.	Harvesting (person/day)	8×250=2000
8.	Transportation (Rs.15/100 kg)	7500
9.	Other	6000
10.	Total expenditure	37400
11.	Gross income (50 t ha ⁻¹)	506× 163=82478 (Rs.163/maund)
12.	Net income	82478-37400=45078

Table 5: 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
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

Table 6: Support/Indicative Price of Sugarcane and Sugar Beet

Year	Price (Rs./40 kg)	
	Sugarcane	Sugar beet
2001-02	40	38
2002-03	40	38
2003-04	40	38
2004-05	40	40
2005-06	45	55
2006-07	65	60
2007-08	65	60
2008-09	80	80
2009-10	100	95
2010-11	125	120
2011-12	165	158
2012-13	170	163

investment, so it raises the need to subsidize these farming operations to make farming economical for farmers.

Support Prices of Sugarcane and Sugar Beet: The federal government authorizes provincial governments to fix respective crop prices in consultation with representatives of both the sugar industry and farmer's organizations. The minimum prices of sugarcane and

sugar beet are decided by the provincial government of Khyber Pakhtunkhwa as given in Table 6. The tendencies in Support/Indicative prices of the sugarcane and sugar beet are more or less equal with trifling differences between the support/indicative prices and are estimated to increase @ 14.23 and 14.12 per cent per annum, respectively. However, it has been learnt that there generally exists a vast difference between the market prices realized by the growers of both crops. For example, during 2010-11, the sugarcane growers received Rs.200-275/40 kg, higher by 60-120 % than the announced indicative prices of Rs.125/40 kg, whilst the sugar beet growers were given Rs.130/40 kg, higher by 4 % only against the announced minimum indicative price of Rs.120/40 kg.

Sugar beet industry in Pakistan: Sugar beet cultivation is already in production and four beet sugar factories were operating in KPK since 1962-63. The first beet-sugar factory in Pakistan was established during 1963 in Charsadda. The four beet sugar mills in Khyber Pakhtunkhwa (KPK) were Premier Charsadda (Saleem), Takhi-Bhai, Al-Moiz and Khazana, but now only Premier and Al-Moiz are functional. Beet sugar factories operate

Table 7: Data regarding beet sugar mills in KPK (adapted from Pakistan sugar mill association (PSMA) annual report, 2013).

Year	No. of mills	Beet Sliced (tons)	Beet sugar made (tons)	Recovery (%)	Molasses (tons)
2000-01	3	226252	17276	7.64	8684
2001-02	3	316041	29127	9.23	13376
2002-03	3	222063	22066	9.94	8490
2003-04	3	250171	23797	9.51	8684
2004-05	2	120903	11373	9.41	4287
2005-06	2	93518	8934	9.55	3404
2006-07	2	83580	7865	9.04	2973
2007-08	2	64095	5532	8.80	2576
2008-09	2	9301	947	10.55	419
2009-10	2	53336	4641	9.15	2140
2010-11	2	151265	13535	8.95	7027
2011-12	2	176709	18216	10.31	8392
2012-13	2	306341	33028	10.78	12040

Table 8: Data regarding two beet sugar mills in KPK during 2012-13 (adapted from Pakistan sugar mill association (PSMA) annual report, 2013).

Mill	Beet sliced (tons)	Sugar made (tons)	Recovery (%)	Molasses (tons)	Recovery (%)
Al-Moiz	258963	28461	10.99	9685	4.97
Premier	47380	4567	9.64	2355	3.40
Total	306343	33028	10.78	12040	3.93

after the end of cane crushing season of November-April. Beet sugar slicing season starts during May and continues up to July-August, depending upon the availability of the crop in sugar beet. Data regarding beet sugar mills in Khyber Pakhtunkhwa is presented in Table 7 and as now only two beet sugar mills are functional and their data is presented in Table 8, which showed that during 2012-13, only 33028 tons of beet sugar was made by two mills in Khyber Pakhtunkhwa and total molasses production was 12040 tons.

Challenges Faced by Beet Sugar Industry: Very low capacity factory operation due to non-availability of sugar beet continues to remain a hefty challenge for mills in KPK, as only two mills are now functional including Al-moiz and Premier and other two mills have ceased to operate due to the dearth of raw material. Lack of interest of sugar beet farmers in increasing the acreage under sugar beet as well to adopt modern production technology due to meager benefits that are reducing due to high input cost, constitutes a major hurdle. High cost of beet sugar production because of non-availability of bagasse is also a big challenge because in case of sugarcane processing, large quantities of bagasse are available that reduce the cost of cane sugar, but in case of sugar beet, there are no usable bagasse, thus cost of beet sugar production increases. The processing of beet is economical together with sugarcane but not alone. To develop high yielding varieties for other regions of Sindh and Punjab is a big task, such varieties that thrive best in different climates of Sindh and Punjab. Continuous

work on development of production technology is also a challenge for researchers to increase the yield and make sugar beet cultivation economical as well as viable choice for farmers. After ensuring a reasonable acreage under sugar beet crop, the new challenge is to shift sugar mill from cane crushing to beet slicing that would require about 300 to 350 million rupees which is a huge investment.

Recommendations: Sugar beet cultivation cannot be successful unless there is a buyer. As the sugar mills are the key players in the chain that offer a market for the sugar beet crop to process it for sugar production. But the sugar mills are reluctant to make investment in modification of the existing mills due to lack of confidence on crop agronomy, sufficient raw material availability, fuel shortage and lack of expertise and technology. The govt. should devise a sugar beet development policy with incentives like duty free import of both new and second hand sugar beet plants, provision of beet seeds and easy access of sugar beet growers to soft loan. The Federal and Provincial agriculture departments should devise beet production technology for each region to conduct large scale trials on different agronomic aspects to come up with an appropriate technology for each area depending on soils and water quality issues. Encourage farmers to first sow beet on trial basis by offering them subsidized/free farm inputs and crop insurance to build their confidence in the crop. To reduce the higher costs incurred on sugar beet processing on account of external source of energy because of non-availability of bagasse,

up-gradation of stem consumption of sugar mills to save energy source through use of local coal and there is need to explore potential market for sugar beet pulp in the country as there is sufficient number of milking and meat animals. Ensure sugar beet growers a guaranteed price for their produce. There should be a pre-arrangement between sugar mills and farmers to ensure that sugar mills will purchase beet produce on harvest. The government should give incentives to the mills in form of waiving all duties and taxes on sugar made from beet. Agriculture Research Institute should develop quality beet seeds for different climate areas. The processing of beet sugar requires different equipment for extraction and processing as compared to sugarcane i.e. beet slicing, beet diffusion, liming and carbonization etc. However, the bulk of the equipment of cane sugar factories can still be utilized i.e. weigh bridges, Boilers/steam generation plants, Power generators, Juice heaters, Multiple effect evaporators, Vacuum Pans, Crystallizers, Continuous centrifugal, Batch type sugar centrifugal, Sugar dryers, Packing plants etc. the extra machinery and equipment for sugar beet would cost around Rs.300-350 million each mill that need to be subsidized by government. Pakistan should enter into the area of production of industrial alcohol and gasohol. Converting molasses into industrial alcohol is what needs to be done sooner rather than later. The sugar mill owners of the province are required to turn to making sugar from beet-root, to invest in the requisite equipment and share in the progress and prosperity that beet-root harvesting can bring to this sector.

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