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REVIEW PAPER

Current status and challenges to sugarcane crop in Pakistan: A review

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Abstract

In Pakistan sugarcane is an important agricultural cash crop after cotton. Availability of cultivated land resources and competition between supply of energy and various other commodities like food, sugar, milk and grain have some connotations worldwide. We analyzed internet databases and scientific papers to highlight key facts about the history, current status, distribution, and trends of sugarcane cultivation in Pakistan. Results of this analysis showed that due to many constraints like insect pests, diseases, low yielding varieties and marketing imbalance, area under sugarcane cultivation and yield is very low. Therefore, increased investment in research and policies are needed to increase production of sugarcane. At micro level, it is very crucial to aware the sugarcane growers about the alternative beneficial methods of cultivation and at the macro level making of policies to enhance the efficiency of agriculture. Sowing time, type of soils, selection of varieties, utilization of various other inputs and availability of irrigational water has a great puff on the cultivation of sugarcane crop. When considering input costs and sugarcane productivity, key inputs include urea, DAP, potash, irrigation water, farmyard manure, seed costs, and labor for harvesting.

Keywords: Byproducts, Cultivation, Research, Sugarcane challenge, Support price

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Introduction

Sugarcane was firstly domesticated as a crop in New Guinea around 6000 BC. New Guinean farmers and other early growers of sugarcane chewed the plant for its sweet juice. In the beginning farmers in Southeast Asia and elsewhere boiled the cane juice down to a viscous mass to facilitate transportation but the first known production of crystalline sugar began in Northern India. Around the 8th century AD, Arab Traders introduced sugar from South Asia and the other parts of the Abbasid Caliphate in Egypt, North Africa and Andalusia. By the 10th century, there was no village in Mesopotamia that did not grow sugarcane. It was among the crops brought to the Americas by the Andalusia from their fields in the Canary Island and the Portuguese from their fields in the Madeira Island (Kew, 2014).

Sugarcane is a major agricultural crop which belongs to family poaceae (Uzma et al., 2012; Abbas et al., 2013a). It is a key crop in industrial development as it has the potential to produce various products like sugar, waxes, bioplastic and biofibers and biofuel (Lakshmanan et al., 2005). Sugarcane is an important cash crop. A large proportion of people around the world relies on this crop for their industrial, economic, medical and dietary purpose (Moraes et al., 2015; Abbas et al., 2013b). Sugarcane is a widely grown crop in the area between the tropics and subtropics. Freshly harvested stalks of sugarcane are the agricultural products that should be processed as soon as possible. Processing sugarcane immediately reduces the risk of conversion of sucrose sugar into reducing sugars which ultimately increases the sugar output (Bouma et al., 2011). For normal growth and development sugarcane requires a warm climate i.e. 20 °C. Ratooning is a key factor in sugarcane crop which improve quality, enhance the efficiency and reduce costs and use of energy (Gascho et al., 1973). Sugarcane is a perennial grass belonging to the genus *Saccharum* L. and comprises six different species. It is indigenous to the warm temperate to tropical climates of South and Southeast Asia, although it is now grown in more than 100 different countries around the world (Food and Agricultural Organization [FAO], 2015). Brazil is the 1st largest producer of sugarcane followed by India, China, Thailand, and Mexico (Pandey, 2007). Sugarcane produces 70% of the world's sucrose. Similarly, it has a significant role in obtaining different by-products such as refined sugar, molasses, brown sugar, jaggery, and various other valuable products like biogas production, pulp, biofertilizer, ethanol, and papermaking (Ranuzzi & Srivastava, 2012).

In Pakistan sugarcane is the second most important cash crop just after cotton. It is mainly grown to produce sugar and sugar related products. For various industries sugarcane also produces a range of products like paper and chipboard (Government of Punjab, 2012). The total cultivated area of sugarcane was 1141 thousand hectares during 2014-15 while total production was 62.7 million thousand tons in Pakistan (Government of Punjab, 2015).

Current status

Suitable regions for growing sugarcane

In Pakistan, sugarcane is grown in three zones: tropical Sindh, Sub-tropical Punjab, and temperate Peshawar valley. About 85-95% sugarcane crop in NWFP is grown in various districts like Charsadda, Peshawar, Mardan, Nowshehra, Swabi, Bannu, D.I. Khan and Malakand. In Punjab, districts like Rajanpur, Raheem Yar Khan, Faisalabad, Jhang and Sheikhupura (Government of Punjab, 2015). About 66% of the total sugarcane is produced by Punjab, 26% in Sindh, 8% in Khyber Pakhtunkhwa and less than one percent in Balochistan.

Sugarcane cultivation

Brazil positioned first regarding production of sugarcane with 39% of the total production of sugarcane. India ranked 2nd with 19% of the total world production and china ranked at 3rd position (FAOSTAT, 2015). India is the second largest producer, consumer and trader of sugarcane items. Due to abundance of sugarcane has great attention by the public and Indian government. It provides raw material for other industries and also becomes very important crop as its economic impact on sustainable energy production (Girei & Giroh, 2012). Worldwide almost 105 countries are cultivating sugarcane crop in which area wise Pakistan ranks 4th number, 14th number in production and 60th number in yield. Even though, Pakistan is the 4th largest producer of sugarcane crop in Pakistan but perhaps the lowest yielder in the world. Sugarcane average yield in world is almost 65 metric tonnes per hectare. While average yield of sugarcane in chine is 77.1, India 70.6, Pakistan 46.0, Philippines 92.6, Thailand 92.6, Australia 75.5 and Egypt 105 tonnes per hectare respectively (Alam, 2007).

Sugarcane is a major cash crop of Pakistan and has a vital role in sugar related industries which are second largest agro-industry sector after textile. In value addition of agriculture sugarcane adds up 3.1% on other hand it adds 0.6% in GDP. Sugarcane crop was cultivated on an area of 1141 thousands hectare as compare to last year i.e. 1073 thousand hectares, a decrease of 2.7%. Production of sugarcane is also decreased by 7.6% from 67460 thousand tonnes to 62652 thousand tonnes. About 80-85% of the total sugarcane produced is goes toward sugar production while remaining 15-20% is consumed for Gurr preparation. Gurr is a local variant of sugar which is mostly produced and rarely exported to neighbor countries (Shaheen, 2007). In Pakistan about 99% of the sugar is extracted from sugarcane. Per capita consumption of sugar in Pakistan is 25.83 kg per year. The current shortage of the sugar in country affects the common man and also the government to revise the progress of the sugar industry to control price. Shortage of sugar is being met by the import of sugar from neighbor countries. Even though Pakistan is an agricultural country but presently is not self-sufficient in production of sugar for domestic requirement (Alam, 2007).

Area and production of sugarcane

During the year 2014-15 the production of sugarcane decreased up to 7.1 present as compared to year 2013-2014 (Table 1 and 2). This happened due to decrease in area by 2.7% under sugarcane cultivation as compared to last year. The major factor behind this decrease in area and production is the lack of proper Government policies to facilitate the sugarcane growers. On the other hand, sugar mill owners are unwilling to pay sugarcane support prices fixed by Government to the farmers. In Pakistan, the level of government support for sugarcane growers has a great impact on sugarcane planting decision and yield of crop which results in rise and fall of sugarcane production.

Table 1 Sugarcane area and production

Year	Area		Production (000 tonne)		Yield	
	(000 hectare)	Change %	(000 tonnes)	Change %	Kg/ha	% Change
2010-11	988	-	55309	-	55981	-
2011-12	1058	7.1	58397	5.6	55196	-1.4
2012-13	1129	6.7	63750	9.2	56466	2.3
2013-14	1173	3.9	67460	5.8	57511	1.8
2014-15	1141	-2.7	62652	-7.1	54910	-4.5

ha: Hectare; Source: Pakistan Bureau of Statistics (2016)

Sugarcane cultivation pattern

Generally farmers cultivate sugarcane crop in autumn or spring season because autumn sown crop provide excellent produce due to longer growing season. In Punjab and KPK farmers mostly plant sugarcane crop in spring season and harvesting is carried out after ten month. However, in Sindh the crop is sown in autumn season which allow the crop stand in field for almost 16 months. Planting in autumn provide a great time for maximum accumulation of sucrose content in sugarcane which potentially netting the grower a better price from the sugar mills. There are many factors which are responsible for better growth and development of sugarcane. However, shortage of good quality water, lake of high yield producing verities, uneven application of pesticides and fertilizer results in relatively low yield of sugarcane in Pakistan.

Table 2 Province wise area and production sugarcane

Province	Area (000 hectare)					Production (000 tons)				
	2010-11	2011-12	2012-13	2013-14	2014-15	2010-11	2011-12	2012-13	2013-14	2014-15
Punjab	761	770	755	800	750	37481	42893	42982	43704	41074
Sindh	189	205	250	267	248	13766	10788	15966	18362	16614
KPK	105	106	104	110	102	4030	4684	4770	5361	5107
Balochistan	1	1	1	1	1	30.8	30.8	31.5	32.2	31.6

Source: Ministry of National Food Security and Research, Islamabad

Scientific research

Research and development is key factor which ensure sustainability of an industry. A small industry remains in efficient because it can beg or borrow technical information from other industries. However, an industry with national or international standards has different scenario. Sugarcane is second major cash crop after cotton but there are no sustained efforts for sugarcane improvement (Silalertruksa et al., 2015). With proper and adequate research and funds it is feasible to develop sugarcane new varieties having resistance against pest infestation and have better yield potential. For improvement in sugarcane yield there is dire need to adopt proper cultural approaches which are helpful to avoid the insect-pest and diseases infestation (Akhtar, 2000).

In different ecological zones of Pakistan there are eleven research institutes are working on diversified aspects of sugarcane crop. Out of the eleven research institutes, Punjab has six, Sindh has three and NWFP has two sugarcane research institutes. The aspects covered by the above mentioned research institutes are development of new sugarcane varieties, insect pest control through biological mean, propagation of top clone through tissue culture, disease tolerance and insect resistance studies, different agronomic approaches for yield enhancement. In addition, these institutes organize workshops and seminars on research and development activities on sugarcane crop. They also provide scientific training to researchers within and outside the country (Tariq et al., 2007).

In Pakistan research on sugarcane is very limited due to inappropriate breeding facilities and financial problems. These limitations are major hindrances to meet the existing and future challenges of sugarcane breeding, development of new varieties, agronomic practices about sugarcane and industrial research. Flowers of sugarcane only produced in lower Sindh, Malakand agency and hills of Murree. However, production of viable seeds of sugarcane is a limiting factor in Pakistan. So development of new variety mainly depends on varieties imported from other countries and also on fuzz. Although, new technologies like biotechnology serves as complementary tool to cover some sort of problems for further improvement in production (Sajid & Pervaiz, 2008). Now a day's selection and evaluation of new sugarcane varieties by fuzz has been a very effective practice in various sugarcane research institutes in Pakistan. Genetic variability of seedlings produced from fuzz is exploited by scientists in making selection (Panhwar & Memon, 2004).

Opportunities

Rapid demand for sugar and other products

Approximately three-quarters of the total sugar produced are consumed by the developing countries. In future, demand of sugar and sugar based products will be increased in the form of sweeteners, processed products, sugar-rice confectionery and soft drinks. Due to population growth and urbanization, increased income and dietary patter, Asia leads in sugar demand followed by Africa (Organization for Economic Co-operation and Development, 2015). However on the other hand, demand of sugar is stagnate in well developed countries. This is because of controlled population growth, changes in dietary pattern, health risks related to use of sugar like obesity and diabetes and interventions of government to decrease intake of sugar (Euromonitor International, 2014).

Like other developing counties due to load of increasing population, Pakistan is also facing shortage of sugar. Due to increase in demand and lower production, the price of sugar is increasing day by day. In Pakistan, the current shortage and prices of the sugar not only affected the life of an individual but also enforced the government to revise the progress of sugar industry (Rehman et al., 2015). The current shortage of sugar is met by the import of sugar from neighbor countries. Although, Pakistan is a, agriculture based country but unfortunately not self-sufficient in sugar production even for domestic use. However, government of the Pakistan promotes sugarcane production by market support prices just before the cultivating season of sugarcane crop.

Sugarcane is not only grown for sugar purpose to fulfill the dietary requirements. Various other products of sugarcane industry are also having great importance and play a significant role in energy production, medicines and other chemical products. Baggas, press mud and molasses are three major byproducts of sugarcane industry. Various small scale industries are associated with sugarcane industries in term of social and economic status and operate due to these products (Tuck et al., 2012).

Sugarcane with tremendous cultivation potential

Sugarcane is an efficient photo-synthesizers C4 plant which converts up to 2 percent of the incident solar energy into biomass. It is most efficient plant in comparison with all other plants as a converter of solar energy and CO_2. The Photosynthetic rate of sugarcane plant is 12-14 µmol $CO_2/m^2/sec$ (Natrajin, 2005). It requires a tropical or subtropical climate with minimum of 600mm annual rainfall. There are three main zone of sugarcane cultivation in Pakistan i.e. north western, central and southern zones. The climatic conditions of Pakistan are subtropical arid and semi-arid. Climatic condition of lower Sindh is highly favorable with hot and semi-humid climate.

Ratoon is a vital element for production of raw material through-out the world. So the sugarcane yield is greatly affected by the ratoon yield as it adds 40-50% to total sugarcane yield in Pakistan. Effective cultivation of ratoon crop of sugarcane may results in an increase in sugarcane yield and also of ratoon crops. Currently there is a considerable gap between sugarcane yield and ratoon crops. So it is the need of the hour to explicate behavioral difference between the production gaps. Research work on improvement of obtainable yield of sugarcane and early management of ratoon crop is the need of the hour (Shrivastava, 1992).

Government priorities for sugarcane industry development

Due to low per acre yield of sugarcane, low sucrose content, high support prices of sugarcane crop and high cost of cane processing may results in higher cost of production of sugarcane crop. Similarly on the other hand, a significant investment is made on sugar industry by the government (Dias et al., 2013). Thousands of the people are engaged in sugarcane and sugar related activities. The sugar industry has a direct impact on lives of the thousands farmer families. So decision makers are very delicate to increase in prices of sugar and are least concerned with ill-timed import of sugar (Khan et al., 2006). Asif et al. (2005) performed a study and found that sugarcane cultivation may be enhanced by the incentive based policies. Land rent is a major cost factor in sugarcane cultivation which indicates its shortage and high opportunity cost. Another study revealed that sugarcane crop is grown as an important replacement crop for the fulfillment of requirements of sugar producing institutes (Hussain et al., 2006).

Challenges

Small land holdings

Studies have shown that the majority of the farmers did not cultivate sugarcane crop in their whole farm area due to many factor which directly or indirectly influenced the productivity of crop. Area under sugarcane cultivation is reducing as the farmers are shifting from sugarcane cultivation to other crop (Lodhi & Kamil, 2000). Across the world, sugarcane due to its many nutritional and economic uses is very important crop. Small scale growers of sugarcane crop are very important segment of sugarcane production. Although the number of small scale growers is declining from 2000s to the present. So due to decline in number and of sugarcane growers, production of sugarcane is declined (Garside & Bell, 2007).

Agronomic factors

Irrigation management

Scarcity of good quality water for irrigation purpose is also a vital factor which influences sugarcane productivity. Pakistan ranked as fifth largest country in the world of developing countries for its irrigated area. The total canal command area in Pakistan is 16.2 million hectares out of which 20.6 million hectares area is under cultivation. Although even with this type of canal system only 70% of the total water required for sugarcane is supplied (Saeed, 2001). Scarcity of water is major constraint and other costly input affecting sugarcane yield. For production of 1000 kg of sugarcane 0.2 million liters of water is needed. However, water accessibility for sugarcane is stagnant and continuously decline in sugarcane cultivated areas. So, it is the need of hour is to manage the water resources for optimization of sugarcane yield. Losses of water by evaporation from soil surface, run off and percolation from root-zone and losses of water by weeds as high as up to 70%. Water at any stage of growth and development of sugarcane may become a limiting factor which badly influence the growth and ultimately yield of crop. Sugarcane yield and production may be affected by crop variety and developmental stage of crop (Afghan et al., 2002). Judicial use of irrigation through new innovative irrigation technologies is only the alternative for improvement in sugarcane yield.

Nutrient management

Similarly nutrient requirement of sugarcane crop is very high as compare to other crops as this plant is C4 with more potential to assimilate nutrients and high fixation rate for carbon dioxide. So fertilizer unavailability is on time is also a constraint in good production of sugarcane. However, integration of farm yard manure @ 25% along with recommended dose of NPK or bio-fertilizers and trash enhance the productivity of sugarcane. The results of the study revealed that the magnitude of variation in cane yield was marginal when total N is applied with fertilizer alone (Virdia & Patel, 2010). In intensive sugarcane based cropping systems nutrient management approaches should be according to the huge nutrients requirement. It demands incorporation of organics like green manures (legumes), crop residues, bio-fertilizers, by products of sugar factory to increase nutrient use efficiency. Addition of organic sources with chemical fertilizers produces

better results instead sole use of chemical fertilizers. Incorporation of organics not only reduces dependency on chemicals but also helps to correct emerging deficiencies of micro-nutrients (Shukla et al., 2015).

Insect-pest and diseases

Insect pest and diseases are also a factor influencing the crop productivity. Weeds compete with crop plants for light, nutrient uptake and water throughout the growing period of crop which results in greatest loss of cane and sugar yield. The most ignored aspect of sugarcane crop is to make it protected from pest and other disorders. The most important disorders influencing the crop are red-rot, whip-smut, red-strip, rust and mosaic virus of sugarcane. About 10 to 77 percent of yield losses are caused in yield due to different diseases (Bhatti, 2000). Insect pest is also a threat for sugarcane crop. Management of insect pest through bio-control is very effective, economic and eco-friendly approach. Another difficulty faced by the sugarcane grower is the lack of technical information, practical skills and awareness about new innovations which are very important in sugarcane cultivation. Mostly growers are unaware about integrated pest management techniques and their effectiveness (Sidhu, 2013).

Rule for sugar industry in world is that area under sugarcane variety which is excellent in productivity should be of 20 to 25 % of the total area of sugarcane. This rule is very useful in avoiding any un-expected epidemics (Silalertruksa et al., 2015). But unfortunately in Pakistan so many unapproved and also banned varieties are still propagated. There are no measures taken by the government to replace existing unapproved varieties. In Pakistan sugarcane cultivation and yield might be lesser because of unavailability of varieties of short growing period. Up till now almost all varieties available in Pakistan are produced from fuzz imported from USDA-ARS research stations located at Canal Point (CP), Florida, Louisiana USA (Ho), BSES (Q) and CSIRO, Australia (CS), SAARI, South Africa (N), SRI, Sri Lanka (SL), Copersucar (SP) and Cana Vialis, Brazil (CV) and MSIRI, Mauritius (Afghan et al., 2013).

High prices of inputs

High prices of inputs like fertilizers and other chemicals may also be significant factor that affect the production of sugarcane crop. Farmers do not apply enough inputs because high prices of inputs puts a strain on profit margins as sugar prices have not kept pace (Eweg et al., 2009). Rise in the prices of inputs influence the performance and progress of the sugarcane industry. However, the grower of the sugarcane needs to find the alternative ways to reduce the impact of increasing prices of inputs (Conlong & Campbell, 2010). Anderson-Sprecher and Jiang (2014) stated that high cost of production and low cane's price results in low profit for the growers of sugarcane which ultimately affects the cultivation of crop. Because of this several farmers of main production areas shifted to cultivation of other more profitable crops.

Instability in market price

The production cost of sugarcane us estimated through common understating between ministries and sugarcane stakeholders. Minimum procurement price or support price of sugarcane is declared by the government just before the harvesting of sugarcane crop (Government of Punjab, 2012). The support price of sugarcane incorporate cost of production, a certain percentage of benefit and production based subsidy. Although, sometime declaration about the minimum procurement price of crop is delayed by the government which coincides with harvesting period of crop. In these circumstances to reduce post-harvest losses, the growers sell their produce at lower price (Chauhan et al., 2011).

The price policy and lesser cost of production of sugarcane have direct impact on sugar market. The fair pricing system for sugarcane benefits growers, manufacturers, and consumers. The declaration of support price of sugarcane crop before harvesting of crop not only protect the interest of the growers but also encourage and rewards with premium price for the higher sugar recovery rate (Habib et al, 2014). In current situations Pakistan can no longer continue its traditional administrated and insulated agricultural economy due to competitiveness in world trading system and deregulation move by the World Trade Organization of agricultural sector. So we should manage our agricultural policies in line with global trends in agricultural markets so ensuring maximum prices and income to sugarcane growers and sugar producers (Khan et al., 2006).

Conclusion

The conclusion of this whole discussion is that Pakistan is facing various challenges in successful cultivation and lower yield of sugarcane crop. Improvement is achievable by addressing production threats through effective management strategies. The most important threats to lower yield is protection related and lack of high yielding varies of sugarcane. Among the irrigation problems shortage of irrigational water during sowing and summer season is also a major obstacle in sugarcane cultivation. Similarly fluctuations in minimum procurement price (support price) and delayed declaration is also a major hindrance in marketing system.

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