

Unravelling Water Use Efficiency in Sugarcane and Cotton Production in Pakistan

The present Policy Viewpoint explores water use efficiency between the two competing cash crops of the Kharif season, sugarcane and cotton.

It is concluded that the sugarcane crop consumes about 3.5 times more water than the cotton crop. Moreover, one litre of water used in cotton production generates about 4 times higher monetary benefit at both the farm gate and at the processing stage. Sugarcane alone consumes about 42 percent of the total annual household water demand of Pakistan.

Keywords: Cotton, sugarcane, water use efficiency, water pricing, Pakistan

Contribution of Sugarcane

Pakistan ranks 5th among the world's sugarcane producing countries by cultivating it on 1.3 million hectares and with a yield of about 83.3 million tons, giving an average of 62 tons/ha during 2018-19. Most of the sugarcane cultivated area is in the Punjab province (64 percent), followed by Sindh (25 percent), and Khyber Pakhtunkhwa (KP) (11 percent). Sugarcane accounts for 2.9 percent in agricultural value addition and 0.5 percent in the overall GDP (GoP, 2019a). In Pakistan, around 980,000 farmers are engaged in the cultivation of sugarcane and around 5 million employees are engaged directly or indirectly in the sugar business (Malik, 2018). Sugarcane is a very water-guzzling crop, and is grown under irrigated conditions when water is available either through surface canal or underground water.

Contribution of Cotton Crop

Pakistan is the 3rd largest raw cotton consumer and is the 4th largest cotton producer in the world. In 2019, about 1.6 million farmers were growing cotton crop on 2.37 million hectares, giving an average yield of 10.2 million bales (USDA, 2019). Most of the cotton-growing areas are in Punjab (79 percent) and Sindh (18 percent) provinces. Cotton contributes 0.8 percent to the national GDP and 4.5 percent to agricultural value addition. Moreover, the textile industry contributes about 8.5 percent to the GDP and 58.5 percent to the total trade, amounting to US\$9.9 billion (GoP, 2019b). The sector employs 15 million people in the country, which constitutes 40 percent of the total industrial workforce (GoP, 2018).

*This Policy Viewpoint is based on the webinar organised by the Pakistan Institute of Development Economics (PIDE) on the sugar industry in Pakistan on April 10, 2020. In the webinar, a wide range of issues were discussed from water use efficiency to market intervention and trade liberalisation.

The authors thank to Dr. Nadeem Ul Haque and Dr. Durre Nayab for their valuable inputs, and Mr. Mudassar Ali for providing useful tips in the analysis. Any error is the sole responsibility of the authors.

¹ Sugarcane converts to sugar while raw cotton (*phutti*) converts to cotton lint, cotton seed is separated from raw cotton to make edible oil.

Pakistan Sugar Mills Association's Perspective

According to the evidence presented by the representative of the Pakistan Sugar Mills Association (Khan, 2020), sugar requires 1500-2000 litres of water per kg, while lint cotton requires 10,000 litres of water per kg. This comparison relates to the second stage of the value chain i.e. after completing the first stage of processing². Based on Verma (2016), it is further added that per month water requirement is the same (150 mm) for both sugarcane and cotton crop at the farm gate stage. Based on these statistics, one may conclude that sugarcane is more water-efficient than cotton. But cotton crop takes only 4 to 5 months from planting to harvest while sugarcane takes 11 months, implying that longer crop duration of sugarcane makes its total water demand more than double to that of cotton. Despite the difference in the crop duration, per month water requirement of sugarcane and seed cotton (*phutti*) is 182 and 167 mm, respectively (Bhaskar, 2019). Our estimate also supports the existing literature that per month water requirement of sugarcane (208mm/month) is significantly higher than cotton (147mm/month). Hence, the conclusion that sugarcane is a more water-efficient crop is misleading.

The average yield of cotton and sugarcane are 286 kg/acre and 24,668 kg/acre, respectively (GoP, 2019b). We converted lint cotton to seed cotton by using the conversion factor of 0.43 (CIRAD, 2009). By using the concept of per kg water requirement for each crop, the current Policy Viewpoint estimates per acreage water requirement for both cotton and sugarcane, as presented in Table 1. We then estimate the water use ratio by dividing the water requirement of sugarcane per acre with the water requirement of cotton per acre, also presented in Table 1. The estimated water use ratio (3.4.) reveals that relieving one acre from sugarcane can provide water to about 3.5 acres of the cotton crop.

Table 1

Water Requirements and Monetary Benefits

Crops	Water Requirement (litter/kg)	Yield (kg/acre)	Per acre water requirement (litter/acre)	Water use ratio per acre (sugar/cotton)
Cotton (<i>phutti</i>)	4300	833	3581473=a	b/a=3.4
Sugarcane	500	24,668	12334028=b	
Wheat	1909	1167	2227250=c	(b/(a+c)) =2.1
	Monetary benefits from water usage (Rs/Litter)			
Crops	Net benefit at the farm-gate (Rs/litter)	Benefit ratio	Retail level (Revenue Rs./litter)	Benefit ratio= (e/d)
Cotton (Lint)(b)	0.0100=d	(d/e)=3.9	0.013=g	g/h=3.8
Sugar	0.0026=e		0.004=h	
Wheat (c)	0.0017=f	((d+f)/2)/e)=2.3	0.021=i	((g+i)/2)/h=4.9

Source: Authors' estimations.

² Sugarcane converts to sugar while raw cotton (*phutti*) converts to cotton lint, cotton seed is separated from raw cotton to make edible oil.

Cotton-wheat cropping system competes with sugarcane, implying that sugarcane is substituting two crops i.e. cotton and wheat. Therefore, it is rational to compare the returns of water used in sugarcane with the returns from cotton-wheat system rather than cotton only. For this purpose, we estimated water use efficiency per annum basis. Our results reveal that relieving one acre of sugarcane can support 2.1 acres of both cotton and wheat, implying that cotton-wheat as a system is also more water-efficient than sugarcane cultivation.

Comparison of Water Use Efficiency

The yield of cotton and sugarcane is 286kg/acre and 24668kg/acre, respectively (GoP, 2019), indicating a huge difference in terms of weight. Because of the weight of sugarcane, when we estimate water requirement per kg it goes drastically down for sugarcane (i.e. only 500 litres per kg compared to 4300 litres for cotton).

Revenue is strongly influenced by the price per kg. Farmgate price of raw cotton and sugarcane are Rs.105.6/kg and Rs.4.3/kg respectively (AMIS, 2020), implying that the price of raw cotton is 25 times higher than sugarcane. Therefore, water use efficiency criterion based on the quantity (weight) of crop produced presents an erroneous picture because higher quantity (weight/acre) produced does not warrant higher monetary value. Similarly, the duration of the cotton crop is only 5 to 6 months while that of sugarcane is 11 months, implying that even if the water requirement per month is the same for both the crops, the total water requirement per crop season will be significantly higher for sugarcane because of its longer duration. Therefore, the water use efficiency criterion should be based on the monetary value each crop produces. By employing farm-gate prices for the year 2018-19 and cost of production SBP (2020), this study estimates the net return of each litre of water used in sugarcane and raw cotton. At the farm-gate, one litre of water in sugarcane and cotton production generates a monetary value of Rs.0.0026/liter and Rs.0.0100/litre, respectively. This simple analysis demonstrates that cotton production is about 4 times more water-efficient than sugarcane production. Our yearly analysis reveal that one litre of water used in cotton-wheat system generates 2.3 times higher net return than sugarcane.

This difference in the monetary value reduces slightly when the same analysis is repeated at the second stage of value chain i.e. after converting sugarcane to sugar and raw cotton to cotton lint. The difference reduces because, in the case of sugar, value addition takes place while in case of cotton lint only cottonseed is separated from raw cotton. It is important to note that one kg of sugarcane is producing less than 100 grams of sugar (SRDB, 2019) having a market value of Rs.7 (under the assumption that retail price is Rs.70/kg), while one kg of cotton contains 43 percent fibre (cotton lint) and 54 percent seed and remaining 3 percent wastes. Cottonseed is used to extract edible oil, with 10 kgs of seed cotton giving one litre of edible oil (CIRAD, 2009).

In our analysis, the total revenue is estimated from edible oil and cotton lint by using standard market prices. Wheat is converted into wheat flour, and the price of wheat flour used in the analysis is Rs.40/kg. Our results demonstrate that each litre of water used in raw cotton production generates 3.8 times higher revenue than sugarcane at the second stage of the value chain. However, our analysis on per annum basis demonstrates that each litre of water used in cotton-wheat system generates 3.9 times higher revenue than sugarcane (Table 1). The cost of production of sugar from sugarcane and to convert cotton seed into edible oil is not known, therefore, comparison in terms of net return at the second stage of the value chain is not possible. However, if we compare the return of water use at the retail level for both sugarcane and cotton, we find a widening difference. It is well documented that 250 grams of

cotton produce one shirt (Hoekstra, 2013) and each shirt has an average market value in the range of Rs.1000 to Rs.2000. If we assume the average price of a shirt at Rs.1500, 10,000 litres of water would generate Rs.6000, which is equivalent to Rs.0.6/litre at the retail level. However, one litre in the sugarcane production generates a monetary benefit of only Rs.0.005 at the retail level. Again, analysis at the retail level unravels that each litre of water used in cotton production generates about 171 times higher monetary benefits than sugarcane (Table 1).

Moreover, the textile industry processes raw cotton to finished products by providing employment that is manifolds higher than the sugar industry. However, these additional employment benefits are not included here. This demonstrates that the monetary benefits of water use efficiency in cotton production are significantly higher than that of sugarcane at both farm and retail levels if measured accurately.

Sugarcane Consumes Higher Water than Total Household Water Demand in Pakistan

Using the area allocated to the sugarcane and cotton crop during 2019, we find that the water usage in sugarcane production is sufficient to provide 100 litres/day of water to at least 42 percent of the total population of Pakistan. We take the 100 litres/day benchmark because according to the World Health Organisation (WHO, 2003), a maximum 100 litres of water per person per day is needed to ensure that most of their basic needs (i.e. drinking, personal sanitation, washing of clothes, food preparation and personal and household hygiene) are met. This demonstrates that the water crisis at the household level can be managed by avoiding cultivating sugarcane in a water stress country like Pakistan.

Water Pricing Mechanism

Lack of proper water pricing mechanism fails to discourage water-intensive crops such as rice and sugarcane in the country. A negligible fixed price of irrigation water per annum per acreage (*Abiana*) leads to promoting water-intensive crops because the actual water cost is not appearing in the profit function. True water pricing mechanism in the agricultural production system will lead to eradicating water-intensive crops through farmers' profit maximisation approach. This will not only help Pakistan's agricultural sector to move towards efficient allocation of the land but also promote the adoption of water-saving technologies, especially in water-intensive crops to minimise the cost of production.

Sensitivity Analysis

- Using the per-acre cost estimated by the SBP (2019), we find that at the current *abiana* fixed rate, the net profit per acre of cotton and sugarcane is Rs.35975 and Rs.31,839, respectively—a small difference.
- When we increase the water price from a fixed-rate (of Rs. 200 per annum) to Rs.0.0026 per litre (the actual cost) the net profit of sugarcane approaches a negative value while the net profit of cotton reduces by 24 percent from Rs.35975 to Rs.26663 per acre. It is important to note that the price of 5000 litres of water tanker ranges between Rs.1000 to Rs.3000 in Islamabad while the price we induced in the sensitivity analysis is just Rs.13 per tanker of the same capacity.

Moving from fixed charge for water to a metered usage will, thus, discourage adopting water-intensive crops such as sugarcane.

Unnecessary Market Interventions

One question remains unanswered that why cotton is not competing with sugarcane at the farm level. To let cotton production compete with other crops, the government needs to refrain from interfering in the free market mechanism by eliminating subsidies and price support

Markets distorted by bad policy lead to erroneous farmer decisions. Price supports, export subsidies, and the tariff on imports have created an artificial environment for the sugar industry. The resources spent in distorting the market can be allocated to develop high yielding varieties of cash crops (cotton, rice and sugarcane). This will certainly improve crop productivity, along with improving our external accounts.

PIDE's Recommendations

- Let the sugar market work without government intervention, by allowing it to generate signals that make farmers respond to the market.
- Remove support price, subsidy on export and control/slash high tariffs on the import of sugar.
- Abolish the current flat rate for water and appropriately price it by usage and covering the costs of maintenance and storage.
- High yielding and relatively low-risk varieties need to be introduced by involving the private sector.

References

- AMIS (2020). *Agriculture marketing information service*. Directorate of Agriculture (Economics and Marketing), Punjab, Lahore. <http://www.amis.pk/>
- CIRAD (2009). *Cotton seed oil as a fuel*. <https://www.cirad.fr/en/our-research/research-results/2008/cottonseed-oil-as-fuel>
- FAO (1986). *Irrigation water management: Irrigation water needs*. (Irrigation Water Management Training Manual No. 3). A manual jointly prepared by International Institute for Land Reclamation and Improvement and FAO Land and Water Development Division.
- GoP, (2018). *Sector brief*. <https://invest.gov.pk/sites/default/files/inline-files/Textiles.pdf>
- GoP, (2019a). *Agricultural statistic of Pakistan 2019*. Islamabad: Ministry of National Food Security and Research (MNFSR). Government of Pakistan.
- GoP, (2019b). *Pakistan economic survey 2018-19*. Islamabad: Ministry of Finance.
- Hoekstra, Y. A. (2013). *The water footprint of modern consumer society*. Routledge. 2 Park Square, ISBN. 1136457046, 9781136457043
- Khan, N. A. (2020). Pakistan's sugar economy: A fact-based presentation. Presented in Webinar, "Sugar Industry in Pakistan" organised by Pakistan Institute of Development Economics (PIDE) on April 10, 2020.
- Malik, K. B. (2018). *Book on agricultural and industrial aspects of sugarcane production*.
- SRDB (2019). *Annual report for Punjab sugar policy, 2019*. Sugar Research and Development Board.
- SBP (2019). *Indicative credit limit and eligibility items for agriculture financing 2019*. Agricultural Credit and Micro Finance Department. State Bank of Pakistan.

USDA (2019). *Cotton and products annual 2019*. USDA Foreign Agricultural Services. (GAIN Report No. PK1908). Dated: 4/2/2019.

Verma, A. (2016). Sugar industry is water efficient. Financial Express, daily newspaper published from India. May 10, 2016.

World Health Organisation (WHO, 2003). Office of the High Commissioner for Human Rights (OHCHR), Centre on Housing Rights and Evictions (COHRE), Water Aid, Centre on Economic, Social and Cultural Rights. *The Right to Water*. 2003. http://www2.ohchr.org/english/issues/water/docs/Right_to_Water.pdf.

Prepared by:

Abedullah Anjum and Uzma Zia

Email: abedullah@pide.org.pk Tel: 051-9248024

PIDE Policy Viewpoint is an initiative for an informed policy-making through evidence-based research conducted at PIDE. It aims to bridge the research-policy gap and improve the public policy process in Pakistan.

Pakistan Institute of Development Economics

www.pide.org.pk