



GSJ: Volume 7, Issue 3, March 2019, Online: ISSN 2320-9186

www.globalscientificjournal.com

A face for enhancing cane & sugar yield in Pakistan

Dr Muhammad Ijaz Tabassum **, *Dr Mohammad Ishaq Javed, *Iftekhhar Nabi*
*****, *Dr Naeem Ahmad*****, *and Dr Abid Mahmood *******

ABSTRACT

Sugarcane Research Institute (SRI), Faisalabad is located in the almost center of the Punjab province in Pakistan. It is somewhat lying in the range of tropical atmosphere. However, the main objective of this prime institute of the province is to develop high yielding varieties under biotic and a-biotic stresses. Twenty four varieties of sugarcane crop have been evolved/developed by this remarkable institute for the economic development of not only sugarcane's farmers but sugar industries of the Punjab are also getting maximum advantages from these varieties being maximum sugar recoveries in the varieties. Around more than ninety percent area of sugarcane cultivation is come under the varieties released by this institute. *Rajapur* area of the province is gaining 93 tons per hectare yield and it is more than the average of world average yield in sugarcane crop to promote the SRI, Faisalabad as enhancing cane & sugar yield in the motherland.

KEY WORDS

Sugarcane, Institute, yield, varieties, sunshine hours, staff members, rainfall, sugar recovery

** Assistant Botanist (Genetics,) Sugarcane Research Institute, Faisalabad*

*** Agri Economist, Economics Section, AARI, Faisalabad*

**** Assistant Research Officer, Economics Section, AARI, Faisalabad*

***** Director, SRI, Faisalabad*

**** * **** *Director General Agri.(Research), Ayub Agricultural Research
Institute, Faisalabad*

Corresponding author: drijaztabassum07@gmail.com

INTRODUCTION

There are ten (10) institutes in which research oriented activities in sugarcane crop are carried out in Punjab. In private sector, nine places like Shakarganj Sugar Research Institute (SSRI), Jhang, Jamal Din Wali (JDW) Sugar Mills, Rahim Yar Khan, Ramzan Sugar Mills, Chiniot, Almoiz Sugar Mills, Mianwali, Noon Sugar Mills, Bhalwal, Safina Sugar Mills, Lalian, Jauharabad Sugar Mills, Jauharabad, Layyah Sugar Mills, Layyah and Fatima Sugar Mills, Kot Addu, while in public sector, only one place of Sugarcane Research Institute(SRI), Faisalabad is directly dealing with research and development activities in sugarcane crop.

SRI, Faisalabad approaching nearly to the center of the province Punjab with North latitude 31.4504° and East longitude 73.1350° (Malik 2009). It is one of the major institutes in the province who is evolving high cane and sugar yielding varieties. The annual average temperature ranged from 18 to 32° C and annual average rainfall from 437 mm (Table 1). The drought condition or spells are often experienced commencing from the autumn (October) upto before the onset of spring (February) in Faisalabad (Table 2). Rainfall is, however, plenty during monsoon period of July to September in the city which is actually the rainy season because around 70% precipitation of the year is received during this period (Table 2). Keeping in view the amount of precipitation to the sugarcane crop, is very much necessary for enhancing the cane weight that ultimately effects positively to the cane yield (Biswas 1988). Availability of precipitation during this critical stage is considered to be the blessing of God as provided the mineral water to the sugarcane crop on this developmental phase

As for as concerning the sunlight received BY the crop, total sunshine hour in average of the year highlighted in Table 3 is depicted that the sunshine of 225 hours with 27 minutes was received on an average throughout the year since 2010, with the mean per day solar light of 7 hour with 39 minute to the sugarcane crop in Faisalabad. The month of May was considered to be the hottest month of the year for the last eight year (Table 3), when the sugarcane crop was entering into the elongation phase after tillering. Therefore, total sunshine hour in the May was received on an average of 294 hours with 50 minutes since 2010, with an average of per day of 9 hour with 50 minute of solar light was received to the sugarcane crop. This plentiful solar light in term of sunshine hour is favored for the cane elongation and its maturation (Malik 2018). However, atmospheric conditions of Punjab, particularly Faisalabad are good for the cane growth with elongation and sugar accumulation (Blume 1986).

Although the required humidity (80 to 85%), temperature (20 to 26⁰C) and the length of dark night (11 hour and 30 minute) is not available sufficiently for the proper establishing the cane flower in the Punjab province of Pakistan (Hunsigi 1993, 2001). However, then eventually, fertilization of male and female part of the sugarcane flower is difficult, that is why we are dependant to take fuzz (true seed of sugarcane) from global breeding institutes for executing the sugarcane varieties (Ali 1996, Nair 2005, legendre and Burner, 1997).

SUGARCANE PRODUCTION IN PUNJAB

Punjab is the main producer of sugarcane in the country (Kanwar 1991). At the time of independence, sugarcane was cultivated on the area of 133 thousand hectares. Total production of sugarcane was estimated at 3.9 million tons with an average of 29.72 tons/hectare. During 2016-17, sugarcane was cultivated on 777.78 thousand hectares. Its production accounted for 49.6 million tons with an average of 63.78 tons/hectare (Javed *et al.* 2018). It means during 70 years (from 1947 to 2017) area under sugarcane has increase 5.8 times while its production has increased 12.5 times while its average has almost doubled during this period (Table 4).

In Punjab, sugarcane is cultivated in 33 districts (Table 5). District wise area (000 hectares, production (000 tons) and yield (Kg/ha) of sugarcane in Punjab for the crop year 2016-17 is presented in Table 5. It is depicted that Rahim Yar Khan (RYK) is leading sugarcane growing district of the Province with 156.21 thousand hectares followed by Faisalabad with 108.86 thousand hectares, Sargodha with 59.08 thousand hectare, Muzaffargarh with 53.01 thousand

hectares, , Jhang with 49.78 thousand hectares, Chiniot with 42.90 thousand hectares, T.T. Singh with 38.85 thousand hectares, Rajanpur with 29.95 thousand hectares, Bahawalpur with 25.49 thousand hectares and Bhakkar with 25.09 thousand hectares. During the crop year 2016-17, highest average yield of sugarcane (93339 kgs/hectare) was recorded in District Rajanpur (Fig. 1, Table 5) followed by Rahim Yar Khan with 78766 kilograms, Bahawalpur with 68252 kilograms, Muzaffargarh with 66868 kilograms, Khanewal with 66499 kilograms, Dera Ghazi Khan with 65116 kilograms, Bhakkar with 65669 kilograms, Lodhran with 64931 kilograms, TobaTek Singh with 62349 kilograms and Jhang with 61150 kilograms per hectare. All these horizontal and vertical expansion of sugarcane crop have the credit on the face of SRI, Faisalabad who trying her best efforts to make not only self-sufficiency in sugar yield to make sugar bowl of the province but also have the struggle to distribute sugarcane produce to the smaller provinces of the homeland (Malik and Gurmani, 2015).

SUGARCANE RESEARCH INSTITUTE, FAISALABAD

Research efforts for sugarcane varietal yield improvement dated back to 1934 with the establishment of Sugarcane Research Station Faisalabad, then Lyallpur (Babu 1990). The research was supervised by the Sugarcane Specialist, Lyallpur, under the administrative control of the Deputy Director of Agriculture, Lyallpur (Tabassum 2017, Fasihi and Malik 1986). After independence sugarcane research, as a permanent component of the Department of Agriculture, worked under the Punjab Agricultural College and Research Institute, Lyallpur. Earlier, the work was confined to variety testing for Coimbatore cane for the western part of the Punjab. One good variety Co 312 was released during 1934-35 and remained un-beaten till 1954. Later on after independence, three well known commercial varieties like CoL 29, CoL 44 and CoL 54 were evolved (Fasihi and Malik 1986).

In 1962, Sugarcane Research Station became a component of Ayub Agricultural Research Institute, Faisalabad. In 1977, Sugarcane Research Station was upgraded to Sugarcane Research Institute (Fasihi and Malik 1981). Research System of Ayub Agricultural Research Institute, Faisalabad has released 24 sugarcane varieties so far for general cultivation in Punjab including mega varieties like BL 4, CP 72-2086, CP77-400, SPF 234, HSF 240, CPF248 and CPF 249 (Table 6).

To evolve sugarcane varieties is a continuous process keeping in view the ever changing biological scenario as well as the needs of the sugar industry (Sundara, 2000, Verma 2004). Sugarcane varieties developed by SRI, Faisalabad's research system have been widely appreciated and adopted by the sugarcane growers in Punjab and also in other provinces of the country. During 2016-17, share of SRI, Faisalabad's varieties in sugarcane cultivation of Punjab (Table 7) was on the area of 92% (Javed *et al.* 2018). Among these, 34.54% area of sugarcane cultivation is covered by one of the legends variety of SPF 234 followed the area of 32.14% by another prominent variety HSF 240 in the province. Credit of the existing of these two varieties are eventually, given to the scientists of SRI, Faisalabad who work day and night for prosperous the nation.

Acreage of such huge cultivation of sugarcane varieties in Punjab is actually belongs to SRI, Faisalabad which approved and recommended for general cultivation by the Government of Punjab. So, research in sugarcane is carried out across the province under the umbrella of SRI, Faisalabad. It has two research stations located at Khanpur and Sargodha with the name like Sugarcane Research Station (SRS) and two sub-stations located at Bahawalpur and Murree as the name of Sugarcane Research sub-station (SRSS) and Sugarcane Breeding Sub-Station (SBSS), respectively are engaged in research and development activities with the problems of farmers of grass root level and efforts are also being done to evolve site specific varieties (Anonymous, 2017).

SRI, Faisalabad has given the priority to the application and exploitation of research according to the need of sugarcane growing community. Besides thousands of sugarcane growers, forty six (46) sugar mills of the province have also looking forward to get varieties of new genetic make-up having high cane & sugar yield and resistant to diseases under the scenario of global warming to expand their own activities from SRI, Faisalabad.

Credit is however, also pasted on the face of SRI, Faisalabad for releasing high yielding with maximum sugar recovery varieties (Table 6) along with developing the package of production technology. Uptill now, the average yield of sugarcane in Punjab is 63 tons/ha and in Pakistan is 56 tons/ha while in the world, an average yield of 71 tons/ha is recorded during 2016-17 (Tabassum 2017). After practicing package of technology developed by SRI, Faisalabad, farmers

are obtaining more average yield from varieties evolved by SRI, Faisalabad than the world's average yield on sugarcane crop. Recently, Rajanpur located at southern Punjab excelled more average yield (93 tons/ha) than the world average (71 tons/ha) yield (Javed *et al.* 2018, FAO Stat 2016). On overall basis, the potential of cane yield has jumped from 69 tons/ha to 115 tons/ha, similarly, varieties evolved by SRI, Faisalabad, the sugar recovery of the varieties has been improved up to 12.46 percent (Table 6)

Hence, SRI, Faisalabad has resolved the key scientific problems of sugarcane production during different development stages. At the same time, it provided technology support for sugarcane varieties improvement to the sugarcane stakeholders of the province and refreshing the sugar bowl of the nation day by day alongwith economic development of the farmers.

Now, there are 131 staff member in SRI, F including 7 seasoned & senior scientists, 9 medium researcher and 15 primary researchers with 44 supporting field along with 56 ministerial staff. SRI, F has the total area of 173.8 acre of land for research activities in the province. Maximum area come under sugarcane crop at SRI, Faisalabad with 111 acre of land followed by 46 acre at SRSS, Khanpur, Rahim Yar Khan, 8.5 acre at SRS, Sargodha, 4.7 acre land at SBSS, Murree and 3.5 acre of land is handed over to SRS, Bahawalpur (Anonymous 2017_b). All the research area of 172.8 acre of land of SRI, Faisalabad is divided into the fuzz raising spot, seedlings, nurseries, yield trials, seed multiplication and of course the area under demonstration varieties. The research area of SRI, Faisalabad is also grouped into autumn and spring plantation. On the area of 55% of SRI, Faisalabad is fixed for spring plantation of sugarcane. A sound system of collecting raw material, cultivation on the bases of scientific research has been established in the Institute. Along with training session/ seminars to the scientific community, interneers, farmers, and cane staff of sugar mills, an education in brochures, booklets, pamphlets, radio talks and TV programs are always lying on the canvass of nation to disseminate the information for the knowledge seekers of remote areas of the province.

Conclusion

SRI, Faisalabad has made the pivotal role for the economic development of the farmers in the Punjab by evolving high yielding with maximum sugar recovery varieties. It is the only research and development organization in public sector, whose varieties are being liked by the sugarcane growers. Its varieties are grown on 92 % area of sugarcane cultivation in the province of Punjab. Under the climatic changing situation in the world, SRI, Faisalabad has enormous varieties with diverse parentage in the pipe lines that awaiting for approval for general cultivation in the Punjab revealing the real face for enhancing cane and sugar in the mother land. Farmers are feeling proud of it.



Table 1: Minimum mean, highest maximum and maximum mean temperature of the hottest month (May) of the year alongwith Rainfall data from 2010-11 to 2017-18*.

Year	Temperature °C			Rainfall (mm)
	Minimum mean	Highest maximum	maximum mean	
2010-11	16.4	46.2	31.0	761.3
2011-12	17.2	46.8	31.2	506.5
2012-13	17.6	47.5	31.1	412.3
2013-14	17.9	44.5	31.4	293.7
2014-15	17.8	44.5	30.7	475.5
2015-16	18.4	46.0	31.6	440.9
2016-17	18.3	45.0	32.2	363.7
2017-18	21.2	46.0	31.6	243.6
Mean	18.1	45.8	31.35	437.1

Physiological section, Agronomic Research Institute, Faisalabad

Table 2: Month wise Rainfall (mm) occurrence in Faisalabad during 2010-11 to 2017-18

Month	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Mean
July**	300.3	164.4	63.0	14.8	65.2	126.7	154.5	111.0	124.99
August**	273.1	114.5	24.0	144.9	6.7	51.6	68.1	65.7	93.59
Sep.**	71.1	169.4	147.9	3.0	209.0	64.4	5.8	19.0	86.20
October*	-	T	21.0	-	3.6	13.6	25.0	-	7.90
November*	-	T	T	1.6	22.0	T	-	1.1	3.09
December*	0.5	-	16.4	-	-	T	-	3.8	2.59
January *	T	3.2	3.2	-	12.4	12.2	11.9	-	5.36
February*	26.8	6.3	54.3	11.2	23.3	5.8	3.7	7.2	17.33
March	6.0	1.8	1.9	30.6	58.7	78.0	16.1	12.4	25.69
April	19.5	35.4	19.0	22.5	20.8	6.1	19.2	11.4	19.24
May	12.0	0.10	1.4	63.5	20.0	41.0	5.4	12.0	19.43
June	52.0	11.4	60.2	1.6	33.8	41.5	56.0	-	32.06
Mean	761.3	506.5	412.3	293.7	475.5	440.9	363.7	243.6	-

* drought months **precipitation months

© GSJ

Table 3: Total sunshine hour of the year vs sunshine hours of the hottest month (May) of the year*

Year	Sunshine hour in average of the year	Mean per day sunshine hour	Sunshine hour in average of the May	Mean per day Sunshine hour
2010-11	228.21	7.33	299.25	9.40
2011-12	232.40	7.38	298.30	9.38
2012-13	225.20	7.23	318.10	10.16
2013-14	230.22	7.34	295.25	9.32
2014-15	221.15	7.16	304.35	9.50
2015-16	220.00	7.12	293.40	9.28
2016-17	223.00	7.23	285.20	9.12
2017-18	218.00	7.08	260.45	8.25
Mean	225.27	7.39	294.50	9.50

Physiological section, Agronomic Research Institute, Faisalabad

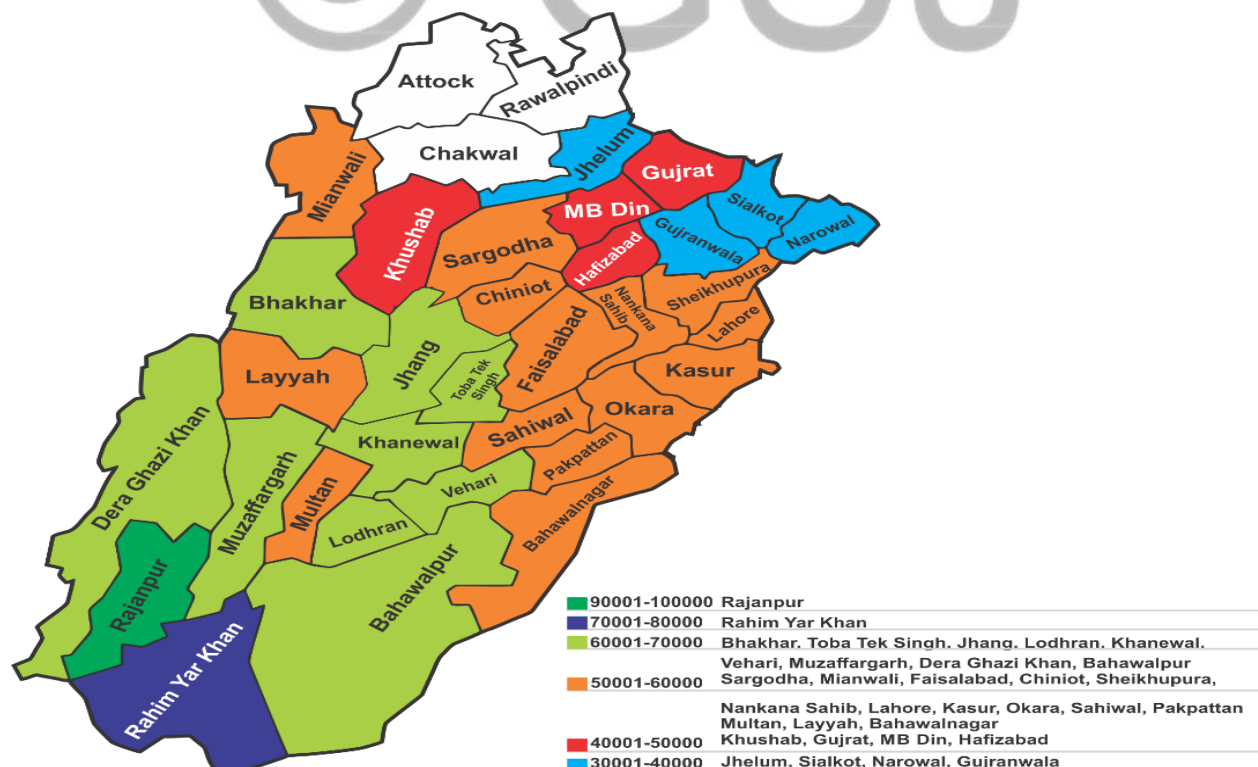


Fig.1 Sugarcane growing area of Punjab

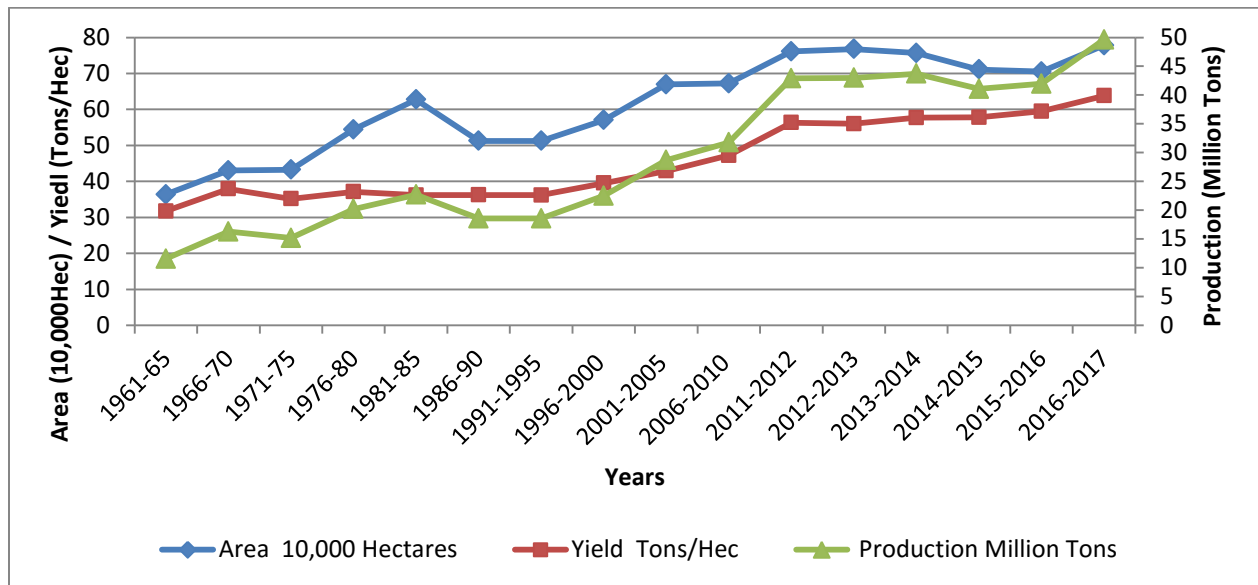


Fig 2: Sugarcane Area, Production and Yield in Punjab

© GSJ

Table:4 Sugarcane Area, Production and Yield in Punjab (1947-2017)

Year	Area (000 ha)	Production (000 tons)	Avg. Yield (Tons/ha)	Year	Area (000 ha)	Production (000 tons)	Avg. Yield (Tons/ha)
1947-48	133.60	3971.70	29.72	1982-83	628.30	20882.40	33.20
1948-49	144.50	5446.00	37.68	1983-84	613.70	22835.90	37.20
1949-50	170.00	6409.20	37.70	1984-85	626.10	20959.00	33.50
1950-51	150.10	4338.50	28.90	1985-86	510.60	16755.10	32.80
1951-52	142.90	4064.20	28.44	1986-87	487.20	18477.70	37.90
1952-53	193.00	5554.70	28.78	1987-88	535.30	19406.20	36.30
1953-54	229.50	7034.10	30.65	1988-89	529.60	19493.70	36.80
1954-55	245.20	6959.90	28.38	1989-90	501.00	18682.90	37.30
1955-56	227.40	6361.50	27.97	1990-91	525.60	19633.40	37.40
1956-57	249.30	6819.70	27.35	1991-92	536.20	20026.80	37.30
1957-58	320.90	8738.00	27.23	1992-93	536.10	20044.80	37.40
1958-59	333.50	9213.50	27.62	1993-94	596.20	24510.80	41.10
1959-60	311.20	8325.50	26.75	1994-95	656.70	28268.00	43.00
1960-61	331.90	8826.40	26.59	1995-96	605.60	26880.00	44.40
1961-62	352.90	11135.90	31.55	1996-97	604.20	24010.20	39.70
1962-63	403.50	13099.90	32.46	1997-98	685.30	32110.60	46.90
1963-64	373.10	12247.50	32.82	1998-99	780.30	33382.80	42.80
1964-65	355.30	12501.50	35.18	1999-00	672.10	27081.30	40.30
1965-66	442.40	15956.00	36.06	2000-01	615.50	26740.00	43.40
1966-67	478.00	15692.80	32.83	2001-02	656.80	31803.10	48.40
1967-68	378.40	13827.90	36.54	2002-03	735.30	33168.60	45.10
1968-69	396.20	16155.20	40.77	2003-04	709.00	34023.00	48.00
1969-70	455.70	19734.00	43.30	2004-05	644.70	33048.00	51.30
1970-71	475.90	16834.00	35.37	2005-06	625.20	28968.60	46.30
1971-72	390.90	13774.60	35.23	2006-07	711.80	37542.00	52.70
1972-73	367.40	13726.90	37.36	2007-08	827.20	40306.00	48.70
1973-74	454.10	16617.50	36.59	2008-09	666.50	32294.70	48.50
1974-75	474.30	14810.00	31.22	2009-10	607.40	31324.00	51.60
1975-76	499.80	18267.60	36.55	2010-11	672.20	37481.00	55.80
1976-77	574.60	21788.30	37.91	2011-12	761.20	42893.00	56.30
1977-78	607.00	22095.70	36.40	2012-13	767.70	42982.00	56.00
1978-79	536.60	19343.90	36.04	2013-14	756.80	43704.00	57.70
1979-80	501.40	19413.50	38.71	2014-15	710.60	41074.30	57.82
1980-81	597.50	23733.00	39.70	2015-16	705.38	41968.20	59.49
1981-82	670.20	25021.00	37.30	2016-17	777.78	49613.00	63.78

(Source: Agricultural statistics of Pakistan various issues & CRS, 2017)

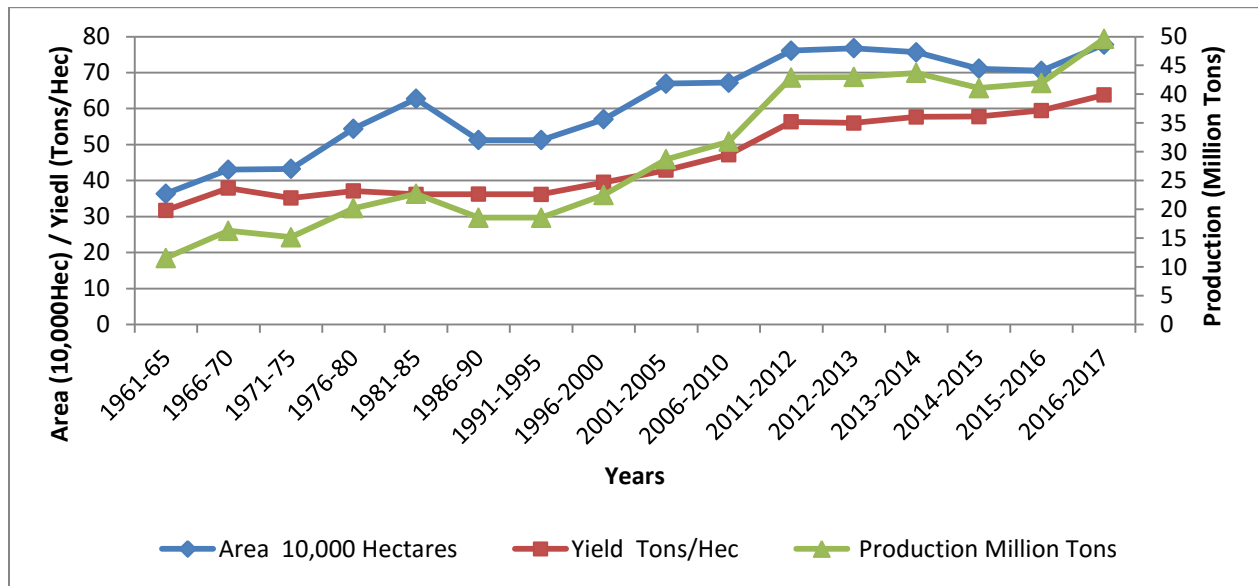


Fig 2: Sugarcane Area, Production and Yield in Punjab

© GSJ

Table 5: District wise sugarcane area, production and yield in Punjab during 2016-17

Sr.No	Name of District	Area 000 Hectares	Production 000Tons	Av. Yield (Kg/ha)
1	Bahawalnagar	14.57	843.83	57922
2	Bahawalpur	25.49	1740.07	68252
3	Bhakkar	25.09	1647.66	65669
4	Chiniot	42.90	2393.62	55800
5	D.G.Khan	8.09	579.73	65116
6	Faisalabad	108.86	6245.07	57368
7	Gujranwala	1.62	62.56	38645
8	Gujrat	2.02	99..84	49344
9	Hafizabad	6.47	305.76	47223
10	Jhang	49.78	3043.78	61150
11	Jhelum	0.40	14.18	35048
12	Kasur	30.35	1576.03	51927
13	Khanewal	6.48	457.49	64931
14	Khushab	8.09	400.12	49436
15	Lahore	0.40	20.57	50820
16	Layyah	13.76	821.07	59674
17	Lodhran	4.45	289.04	64931
18	M.B.Din	24.69	1206.70	48883
19	Mianwali	2.83	144.48	51004
20	Multan	6.07	328.64	54140
21	MuzafarGarh	53.01	3544.90	66868
22	Nankana Sahib	13.36	749.27	56077
23	Narowal	1.21	40.31	33203
24	Okara	12.54	597.79	52757
25	Pakpattan	1.62	87.64	54140
26	Ranjanpur	29.95	2795.16	93339
27	Sahiwal	5.26	278.03	52849
28	Sargodha	59.08	3171.54	53679
29	Sheikhupura	2.43	123.84	51004
30	Sialkot	1.21	38.97	32097
31	T.T.Singh	38.85	2422.22	62349
32	Vehari	19.83	1194.27	60227
33	R.Y.Khan	156.21	12303.82	78766

Source: Crop Reporting Service, Lahore, 2016-17

Table 6 : Characteristics of Sugarcane Varieties developed by SRI, Faisalabad, Punjab, Pakistan.

S.No.	Variety	Year of Approval	Av. yield t/ha	Sugar Recovery (%)	Parentage
1	CoL 29	1954	70	10.10	---
2	CoL44	1954	75	8.93	---
3	CoL54	1963	75	9.63	---
4	BL19	1966	85	9.49	---
5	BL4	1968	85	10.34	PoJ 2878
6	L116	1973	75	10.81	CoL 29
7	L118	1975	83	8.23	S 230
8	Triton	1983	85	10.10	Co 270 x Eros
9	BF 162	1990	90	10.35	Co 1001
10	CP 43-33	1996	80	11.69	Co 281 x CP 1165
11	CP 72-2086	1996	85	12.35	CP 62-374 x CP 63-588
12	CP77-400	1996	90	11.90	CP 66-315 x CP 71-5400
13	CoJ 84	2000	90	9.80	Introduction
14	SPF213	2000	90	10.50	SP 70-1006
15	CPF237	2000	95	12.50	86. P-19 x CP 70-1133
16	HSF240	2002	95	11.70	CP 43-33 x S. 95 – HS-102
17	SPF234	2002	100	11.60	SP 71- 8210 x SP 71 – 6180
18	SPF245	2004	100	11.00	G 6888
19	HSF 242	2006	102	12.50	SPH- 89-2085
20	CPF 243	2006	102	12.55	LCP 81-10 x CP- 80-1827
21	CPF 246	2011	105	12.15	US 90-1093 x CP- 81-14257
22	CPF 247	2011	105	12.25	P 87 -1628 x CP 84-1198
23	CPF 248	2013	112	12.71	CP 89-879 x CP 90-956
24	CPF 249	2016	116	12.46	CP 87-1628 x CP 84-1198

Table 7: Percent Share of AARI's Sugarcane Varieties in Punjab (2000-01 to 2016-17)
(Area %age)

S.No.	VARIETY	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	SPF 213	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.12	0.34	0.60	0.27	1.05	1.18	1.14	0.69	0.72
2	SPF 234	0.00	0.00	0.00	0.00	7.18	9.64	10.28	19.47	22.34	24.08	27.94	25.30	25.31	31.23	35.02	35.26	34.54
3	SPF 238	0.00	0.00	0.00	0.00	0.00	1.94	17.51	16.29	7.35	8.61	8.49	1.86	1.42	1.28	0.00	0.00	0.00
4	SPF 245	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.07	0.36	0.43	0.53	0.96	1.65	2.42	2.62
5	CPF 246	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.75	0.00	0.00	0.00
6	HSF 240	0.00	0.00	0.00	0.00	0.00	0.00	2.35	5.72	14.15	16.81	20.23	25.52	33.95	33.96	37.07	36.01	32.14
7	HSF 242	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.43	0.47	0.48	1.06	1.11	1.02	2.39	2.13	2.91
8	CPF 237	0.00	0.00	0.00	0.00	0.00	0.00	1.71	1.22	2.55	1.14	0.72	1.12	0.95	1.55	1.77	2.71	3.63
9	CoL 54	6.32	5.60	4.02	4.00	3.13	5.18	2.73	0.54	2.91	1.28	1.26	0.80	0.63	0.53	0.11	0.06	0.00
10	CoL 29	2.09	1.50	1.26	1.10	2.00	5.11	1.42	1.71	2.00	1.01	1.38	1.01	1.69	0.91	0.23	0.00	0.00
11	BL4	5.22	4.70	4.12	3.20	2.57	3.56	2.16	0.78	2.43	1.94	1.69	1.49	0.74	0.59	0.06	0.00	0.00
12	BF 162	9.09	11.40	10.30	12.53	12.21	10.68	8.93	9.05	5.77	3.23	4.03	2.29	1.90	1.07	0.28	0.00	0.00
13	L 118	0.13	0.60	3.88	1.20	0.67	0.00	0.00	0.54	0.79	0.00	0.78	0.00	0.74	0.37	0.00	0.00	0.00
14	CP 43-33	3.79	6.00	5.57	6.76	2.28	2.78	1.42	2.01	0.85	4.84	1.87	1.75	3.85	2.94	2.96	2.14	1.47
15	CP 72-2086	0.10	2.30	3.27	4.90	0.58	0.71	0.00	0.34	0.12	0.34	0.66	0.43	0.21	0.16	0.11	0.23	0.15
16	CP 77-400	0.69	3.00	3.16	5.60	8.20	5.44	3.52	4.55	5.59	5.99	6.08	7.02	7.27	6.26	5.30	4.67	5.99
17	CoJ 84	0.00	0.00	0.00	0.00	0.00	5.76	2.84	0.39	0.61	3.16	1.20	1.01	0.47	0.48	0.29	0.58	0.31
18	Triton	4.24	5.30	5.00	3.92	1.81	1.88	0.85	1.57	0.06	0.07	0.12	0.05	0.47	0.00	0.00	0.00	0.00
19	CPF 243	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	1.59	2.37	2.20
20	OTHERS	9.87	8.10	10.76	11.62	16.78	11.13	13.10	12.62	10.68	7.90	6.93	11.75	4.79	3.32	4.22	3.17	5.01
TOTAL		41.54	48.50	51.34	54.83	57.41	66.79	71.04	78.08	79.36	82.49	86.81	83.64	89.62	92.57	94.42	92.44	91.69

References

- Ali, S.A.(1996). Maturity and ripening in sugarcane: an overview. *Indian Sugar* (June):197-203.
- Anonymous (2017_a). Annual Program of Research Work. Sugarcane Research , Faisalabad.
- Anonymous (2017_b). Annual Report. Sugarcane Research Institute, Faisalabad.,
- Babu, C.N.(1990).Sugarcane. Allied Publishers Ltd. New Delhi, India.
- Biswas, B.C.(1988). Agro-climatology of the Sugarcane Crop (Technical Note No.193)
Secretariat of the world Meteorological Organization, Geneva, Switzerland
- Blume, H. (1986). Environment and Cane Sugar Yield.Proc. Int., Soc., Sugarcane Tech., 19:277-288.
- Fasihi,S.D. and Malik, K.B. (1981). Alternate Cane Breeding Area Discovered in Lower Sind (Pakistan). *Proc. Soc.Sug.Tech.*,17:265-273.
- Fasihi, S.D. and Malik, K.B. (1986). Fifty Year Research of Sugarcane, Sugarcane Research Institute, Faisalabad.
- Hunsigi, G.(1993). Production of Sugarcane: Theory and Practices.245. Springer-Verlag: Berlin.
- Hunsigi, G. (2001). Sugarcane in Agriculture and Industry. Rrim Books Pvt., Ltd. Bangalore. India.
- Javed, M.I., Mahmood, A., Ahmad, N., Tabassum, M.I. and Nabi, I. (2018). Impacts of Sugarcane Breeding Research of Ayub Agricultural Research Institute, Faisalabad.
www.aari.punjab.gov.pk
- Kanwar, R.S.(1991). Sugarcane Research in the Punjab.1962-1989. *Sugarcane*: No.1:9.
- Legendre, B.I. and B. M. Burner (1997). New Opportunities in the Development of Sugarcane Cultivars. Augmenting Traditional Approaches with Molecular Techniques. *Sugarcane*, 5:4-10.
- Malik, K.B. and M.H.Gurmani. (2015). How to Increase Sugar Yields Per Hectare. Workshop on Agriculture. *Pak.Sco. Sug. Tech.*(In press).

Malik, K.B.(2009). Cane and sugar production. Punjab Agricultural Research Board (PARB), the Mall Lahore.

Malik, K.B. (2018). *Ganney ki paidawar ke zarai wa sanati pahloo*. SRDB.Almadina Printers, Lahore.

Nair, N.V.(2005). Sugarcane genetic Resources: Collection, Coservation and Utilization.

International Training Courses on Genetic Improvement of sugarcane for Use of Food,

Fuel and Fiber. 12-26, October, 2005. Sugarcane breeding Institute, Coimbatore, India.

Sundara, B. (2000). Sugarcane Cultivation.Vikas Publishing House Pvt. Ltd.New Delhi, India.

Tabassum, M.I. (2017). *Ganna Khet Se Khapat Tak*. Design Studio. Aminpur Bazar, Faisalabad.

Verma, R.S. (2004). Sugarcane Production Technology in India. International Book Distributing Co., Charbagh, Lucknow.

