ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X)

Volume 4 Issue 3 March 2020

Review Article

Glimpses of Sugarcane Varietal Screening and Improvement at Pusa, Bihar

Balwant Kumar*

SRI, DRPCAU, Pusa, Bihar, India

***Corresponding Author:** Balwant Kumar, SRI, DRPCAU, Pusa, Bihar, India.

DOI: 10.31080/ASAG.2020.04.0793

Received: January 18, 2020

Published: February 08, 2020

© All rights are reserved by **Balwant Kumar.**

Abstract

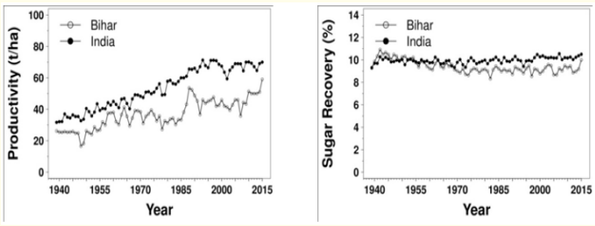
Sugarcane is primarily grown in nine states of India namely; Uttar Pradesh, Maharashtra, Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Punjab, and Tamil Nadu. During early 19th century sugarcane cultivation started as cash crop and number of sugar factories open keeping in view a glimpses of sugarcane varietal screening and Improvement has been reviewed and found that Bihar was rich in term of sugar factories and its 20-40% share in national sugar production was already reported. It was the introduction of Co seedling that replace local varieties under cultivation those were Co 210, Co213, Co 214, Co 313, Co 331, Co 513,Co 356, Co 395,Co 453,Co508 and CoK 32, Co 383, Co 622,Co 419,Co 617,Co1148 and Co 1158 while in present varietal scenario cultivated varieties are Co 0238, Co 0118, Co 98014, CoP 9301, CoLk 94184, CoP 112, CoSe 01434, CoP 09437, BO 154 and CoP 16437. It was also found that POJ 2878, Co285, Co281, CP 28/11, Co213 & Co205 were mainly responsible for improvement in high yield and high sugar. The varietal development and evaluation of sugarcane varieties started in Bihar by after that Central Sugarcane Research Institute was established 1932 since then total 281 clones were developed at SRI, while several Sugarcane varieties of other place were also evaluated. AICRP on sugarcane under North Central Zone altogether 24 varieties were identified out of which 13 were notified for this zone while from SRI, total 10 varieties were identified among them two were notified. During last decade 44 clones were developed at SRI, Pusa and their evaluations were held time to time under water logging condition, red rot resistance and other biotic and abiotic stress as a result of hybridization followed by clonal selection in most of the genetic studied several clones are performing stable with high cane and sugar yield. This is a good sign for varietal improvement work in SRI, Pusa Bihar to release such technology for commercial cultivation which will overcome the past pride moment of sugarcane of Bihar again.

Keywords: Varieties Co, BO, CoP, CoSe, CoLk, SRI, Pusa, AICRP on Sugarcane, Bihar.

Introduction

Present cultivated varieties of Sugarcane (*Saccharum* sps. Hybrids) belongs to family *Poaceae* (*Gramineae*) and the tribe *Andropogonae*, is a major agricultural cash crop next to cotton in India. It act as a major industrial cash crop also, having potential to be a key crop in bio factory evolution as it produces high yield of valuable products like sugar, biofibres, waxes, bioplastic and biofuel In India altogether, 704 sugar factories are open while in Bihar out of 28 only 11 sugar mills are running along with some unorganised small and cottage industry like work has been seen like gur/jiggery and juice for livelihood of rural people of state.

Glimpses of sugarcane cultivation in Bihar has been traced out from early vedic period to middle of the 19th century. How Bihar fell from position of perhaps the primer to producer and supplier of sugar to the world to a position of only one unit among so many has been vividly described [1]. In British India during 1792, sugar rose by degrees to an enormous price in Great Britain. In consequence, the East India Company were called upon to lend their assistance to lowering of the price of sugar. On the 15th of March 1792, his Majesty's Ministers to the British Parliament presented a report related to production of sugar in British India. Lieutenant J. Paterson, of then Bengal establishment, reported that sugar could be cultivated in Bihar with many superior advantages, and at less expense than in the West Indies. As a result, a number of sugar factories were established in Bihar. Presently, Sugarcane is the second most important industrial crop in the India, here sustaining millions of sugarcane farmers and livelihoods on sugarcane production. It was grown in 4.7 million hectares with total production of 355.09 million tonnes and productivity of 74.4 tonnes/ha in India whereas, Bihar has an area of 0.243 million hectare with production of 16.5 million tonnes and productivity 67.9 tonnes/ha [2]. Sugar industry is the only agro-based industry in Bihar needs its revitalization, Even in its present condition it plays significant role in the economy of the state, about 5 lakh cultivators grow sugarcane and factory supports employment generation up to 50 thousand workers annually. Graph 1 showed the relative trends of India and Bihar, no doubt India has made tremendous progress in sugarcane production during the last seven decades as a result the production increased from 35 to 356 Million tonnes after utilization of new sugarcane technologies mostly high yielder and high sugared varieties where as trends of sugar recovery has been found almost uniform i.e. around 10% for India while in Bihar, it showed irregular trends, generally below the national average up to 2015 (Graph) but in recent year 2018-19 sugar recovery of the state rise up that is above than 10% just neck to neck of national level.



Graph 1: Productivity and sugar recovery trend of India vs Bihar (1940 to 2015).

During English empire, Bihar Sugar Industry occupied a place of pride in the rural economy of the state particularly North Bihar, right from early thirties when the state had 35 sugar factories out of total number of 130 factories in the country. Position gradually changed since then and in 2015-16, the state had only 11 functional and operating sugar factories out of 526 in the country [2]. Early nineteen to 1940 in Bihar the sugarcane area mostly covered by local land races viz, Mungo, Katar, Panshi, Bhoria, Hemja, Nargori, Sarbatia, Khosia, Sunable, Khelia and Paroria. The sugarcane varieties which were cultivation in Bihar till status of 20's were mainly of mungo group. The yield potential of those canes were mostly of low order (15 t/ha) with factory recovery not exceeding 8.0 percent therefore it was the urgent need to introduction of developed high yielder, high sugared sugarcane varieties of early maturity in cane growing area of Bihar to Sustain Sugar Industry in state. As we know C.A. Barber worked on many aspects of sugarcane breeding and in basic botany. He established a sugarcane research station that is now known as the Sugarcane breeding institute at Coimbatore (established in 1912) and along with T.S. Venkatraman developed hybrid sugarcane varieties suitable for India, under the Imperial Research Institute, Pusa, Bihar (established in 1905). These included hybrids between local and hardy canes from India which are now called *Saccharum barberi* after him and the tropical high-sugar yielding *Saccharum officinarum* which did not survive in the winter of northern India. This transfer of commercially useful traits from "noble" cane to Indian cane is referred to the 'Nobilization' of Indian canes. During that period in north India, Taylor and Woodhouse at Sabour, Bihar, had done much good work on sugarcane cross breeding. Mr. Wynne Sayer was an Imperial Agriculturist started the work on evaluation of Coimbatore seedlings at Pusa, Bihar with good effort during 1918-1920, by the sugar Bureau and the department of Agriculture. By the year 1923-24, the Coimbatore seedling namely Co 205, Co 210, Co 213 and Co 214 though high sugared and early in maturity could not find favour of growers while two varieties viz, Co 210 and Co 213 were covering up to 80% of total areas under sugarcane due to their high sugar and yield potential resulting successfully replaced the indigenous varieties. Before, 1930 the sugar industry was felt without on early variety of operate the factories economically in early part of their crushing season. The industry was badly in need of and early ripening variety. In order of tackle this problem the central Sugarcane Research Station was established in 1932 at Musheri, Muzaffarpur, Bihar. A comprehensive account of the Coimbatore canes introduced in Bihar since 1923 to enhance sugar and yield potential. Twenty two outstanding varieties among Coimbatore canes from Co 205 to Co 350 were briefly described as regards their agricultural performance and juice quality along with some of their traits, the more important one being Co 205, Co 210, Co 213, Co 214, Co 281, Co 285, Co 299, Co 312, Co 313 and Co 331 during that period.

List of Combatore Seedlings imported in Pusa, Bihar in different years given below as indicated in scientific reports of the Imperial Agricultural Research Institute, New Delhi, Report of the Director 1935-36 [3].

1. **Varieties Imported in 1931**- Co 347 and Co 348
2. **During 1932 and 1933**- Co 366, Co 368, Co 369, Co 370, Co 371, Co 374, Co 375, Co 377, Co 378, Co 381, Co 382, Co 384, Co 386, Co 391, Co 394, Co 412, Co 413, Co 417 and Co 419.
3. **During 1934** - Co 420, Co 421, Co 422, Co 423, Co 424, Co 425, Co 426, Co 427, Co 428, Co 429, Co 430, Co 431, Co 500, Co 501, Co 502, Co 503, Co 504, Co 505, Co 506, Co 507, Co 508, Co 509, Co 510, Co 511, Co 512, Co 513, Co 514, Co 515, and Co 516.
4. **During 1935**- Co 432, Co 433, Co 520, Co 521, Co 522, Co 523, Co 524, Co 525, Co 526, Co 527, Co 528, Co 529, Co 530, Co 531, Co 532 and Co 533.
5. **During 1935**- Co 432, Co 433, and Co 434.

Owing to the immediate transfer of the institute to Delhi, the New Area was discarded for further work on sugarcane and transplanted in the **Botanical Area in February 1936** along with the standard varieties:-

Co 210, Co 213, Co 281, Co 299, Co 313, Co 344,Co 347, Co 348, Co 419, Co 366, Co 368, Co 369, Co 370, Co 371, Co 374, Co 375, Co 377, Co 378, Co 381, Co 382, Co 384, Co 386, Co 391, Co 394, Co 412, Co 413, Co 417, Co 420, Co 421, Co 422, Co 423, Co 424, Co 425, Co 426, Co 427, Co 428, Co 429, Co 430, Co 431, Co 432, Co 433, Co 434, Co 500, Co 501, Co 502, Co 503, Co 504, Co 505, Co 506, Co 507, Co 508, Co 509, Co 510, Co 511, Co 512, Co 513, Co 514, Co 515and Co 516.

6. **During February and March 1936 following clone were received from Coimbatore**- Co 439, Co 440, Co 520, Co 521, Co 522, Co 523, Co 524, Co 525, Co 526, Co 527, Co 528, Co 529, Co 530, Co 531, Co 532 and Co 533.

Figure a

A multidisciplinary sugarcane project, supported by the Indian central sugarcane committee was already operating since 1932 at the provincial government farm at Musheri, near Muzaffarpur which got the legacy of the erstwhile institute, minus the Phipp's laboratory. This project was later shifted to Pusa after the earthquake (1934). After the North Indian and Chinese cultivars have generally showed thinner stalks and leaves, flatter colors and lower sugar content than Nobles, a chromosome number 2n=80 and a better adaptation to sub-tropical environments. They were formerly cultivated in mainland Asia, especially North India (*Saccharum barberi*) and South China, which are probably also where sugar-making industries were born. Nowadays, they are confined to germplasm collections. Five morpho-cytological groups have been described, Mungo, Saretha, Nargori, Sunnabile and Pansahi [4]. The binomial *S. barberior* Jesw usually refers to the first four groups, endemic to India. The fifth group is either included in *S. barberior* referred to as *S. Sinense* Roxb. It was common in China, and was introduced to India at the close of the 18th century. *Saccharum barberi* is a strong-growing species of grass in the genus *Saccharum*, the sugarcanes. It originates from northern India and has been exported to other countries and grown for the production of sugar. The species name commemorates C.A. Barber. Mr. Wynne Sayer, the Imperial Agriculturist, Pusa, was one of the earliest to take notice of the new Coimbatore canes. His interest in them facilitated their quick spread in Bihar "By his position", says Venakatraman, "he was able to introduce these canes into plantation and thus secure early recognition for the Coimbatore breeds".

In 1921, after two years of preliminary trials Wynne Sayer selected three varieties Co 210, Co 213 and Co 214 as likely to be the

best for Bihar. The variety Co 214 was an early ripening cane (ready for crushing early in November) while Co213 and Co 210 were ripened in early December. Sugar factories in Bihar could start working at the earliest in the middle of December as the local cane. Hemja would not be fit for crushing earlier. Wynne Sayer found the new canes a means for extending the crushing season of factories by at least a month. The new varieties also possessed other advantages over hemja. They were hardy and could resist drought well. The hard outer rind of their shoots made them immune from attacks of Jackals and other animals. They gave good yield of cane, Co 213 recorded 800 maund per acre (1 maund = 40 kg: 40x800=32000 kg per acre it means 80 tonne/ha.), Co 210 recorded 700 maund per acre (70t/ha.) and Co 214 recorded 600 maund per acre (60t/ha) while local hemja seldom yielded more than 400 maund per acre (40t/ha). Twenty two outstanding varieties among Coimbatore canes from Co 205 to Co 350 were briefly described as regards their agricultural performance and juice quality along with same of their characters, the more important once being Co 205, Co 210, Co 213, Co 214, Co 281, Co 285, Co 299, Co312, Co 313 and Co 331. In nursery a large number of seedlings raised from fluff use to wither away. On examination the roots were found to have been attacked by nematode and a *Pythium species*. Chesnut compound (a mixture of ammonium carbonate and copper sulphate) mercuric chloride both 1:1000 given alternately once a week were able to control the disease [5]. The history of sugarcane cultivation in India in general and that of Bihar in particular has been traced out from very early times while a comprehensive account of the Coimbatore canes introduced in Bihar since 1923 is given in table 1. The later conditions which led to setting up sugarcane varieties advisory board in 1936 have also been discussed. A full account of the method and need of seed nursery development of promising varieties and withdrawal of discarded ones along with yield trials and mill test data of some of the promising varieties add much to the value of the article [6]. Related to cultural aspects prevailing in North Bihar such as preparatory cultivation, planting, earthing up, operation after earthing up, operation after harvest and improved implements [7]. Bakshi Ram and Rajesh Kumar [8] discussed the Role of Co varieties in sub-tropical India. After transfer of Imperial Institute from Pusa to New Delhi, the Central Sugarcane Research Institute shifted at Pusa had served to satisfy the problems of sugarcane growers in the state by providing novel technologies with prime objective to develop noble sugarcane varieties which can suit agro-climatic conditions viz, water logging, drought, salinity etc. to sustain sugar industry in Bihar. During early thirty a large number of Coimbatore seedling as well as Co clones/varieties had already been introduced from Coimbatore to Bihar evaluated in farmers field as well as in sugar factory area, after obtain significant yield and sugar performance some were released and other were used for studied on flowering behaviour as a result proper hybridization work was stated in 1937 at Pusa to development of BO clones. In nursery a large number of seedlings raised from fluff use to wither away. On examination the roots were found to have been attacked by nematode and a *Pythium species*. Chesnut compound (a mixture of ammonium carbonate and copper sulphate) Merecurichloride both 1:1000 given alternately once a week were able to control the disease [5].

The later conditions which led to setting up sugarcane varieties advisory board in 1936 have also been discussed. A full account of the method and need of seed nursery development of promising varieties and withdrawal of discarded ones along with yield trials and mill test data of some of the promising varieties add much to the value of the article [5]. In search of early maturity variety Co 331 and Co 313 were released in the year 1934. By the end of 1939 the coverage of these two varieties amounted to nearly 40%. The red-rot epidemic of 1939-40 which completely wiped off Co 210 and Co 213 did not affect Co 229 and Co 313 due to the reason by the end of 1940-41 the coverage of these two varieties improved going up to 80 percent in most of the factories area.

The later introductions from Coimbatore i.e. Co 556 and Co 513 were of mid-season group with high tonnage which were multiplied fast and covered at least 33 percent of total crushing in a couple of years. Till, 1947, the Coimbatore originated varieties viz. Co 313, Co 513, Co 395, Co 453, Co 508 and CoK 32 were under commercial cultivation in traditional sugarcane growing belt of North and South Bihar.

In Bihar among the introduced varieties viz, Co 313 and Co 331 were released in 1934, Co 513 in 1937,Co 356 in 1940, Co 395, Co 453, Co508 and CoK 32 in 1943,Co 383 in 1944, Co 622 in 1951, Co 419 in 1953,Co 617 in 1961, Co1148 and Co 1158 in 1972 (Table 1). Till date SRI, Pusa, Bihar developed total 281 sugarcane clones (156 BO and 125 CoP) out of which first variety BO 11 was released in 1946 after that BO10 in 1947, BO 24 in 1951, BO 3, BO21 and BO 22 in 1953, BO 14 and BO 17 in 1955 and other released varieties are listed above in table 1. Most of the important varieties released during early period which were namely; BO 3, BO 10, BO 11, BO 14, BO 17, BO 32, BO 34, BO 43, BO 47, BO 70, BO 76, BO 89, BO 91, BO 99, BO 109, BO 110 and BO 120. Among them the varieties BO 3, BO 32, BO 43, BO 76 had tolerance ability to water logging situation. The varieties BO 47 and BO 70 were most popular one, had once revolutionized the sugar industry through its high tonnage coupled with moderate sugar recovery. Another high recovery bearing varieties viz; BO 90, BO 99, BO 102, BO 120 and BO 128 were of early maturity having with higher tonnage. Wonder sugarcane variety BO 91 comes under mid late maturing group widely adapted under biotic as well as abiotic stresses, it has been performing well since last 41 years in Bihar, Eastern UP and West Bengal resisting it act as a national check under screening of varietal performance of elite clones during last three decades while in case of popularity for high sugar CoP 9301 rank first since 24 years. During last two decade early varieties viz, CoP 9301, BO 130 and BO 120 were performing very well s well as the varieties BO 145, BO 138 and BO 139 were also popular among the farmers field while recently new varieties BO 153 CoP 112 and CoP 16437 (Rajendra Ganna-1) of early maturity are gaining popular among the cane growers as well as the sugar factory management. The midlate maturing varieties namely,

Sl. No	Varieties	Parentage	Yield (t/ha)	Recovery (%)	Year of release	Year of rejection	Remark
1.	Co 313	Co 212 x Co 244	36.5	11.3	1934	1946	Introduction
2.	Co 331	Co 213 x Co 214	47.5	10.7	1934	1945	Introduction
3.	Co 513	PoJ 213 x Co 291	55.0	10.9	1937	1959	Introduction
4.	Co 356	PoJ 2725 x *Sorghum durra*	51.0	10.0	1940	1944	Introduction
5.	Co 395	Co 243 x Co 244	55.0	10.0	1943	1953	Introduction
6.	Co 453	Black Cheribon x Co 285	52.0	10.5	1943	1956	Introduction
7.	Co 508	Co 214 x Co 214	54.0	10.8	1953	1959	Introduction
8.	CoK 32	PoJ 2878 x Co 331	56.0	11.2	1943	1959	Introduction
9.	Co 383	PoJ 2575 x Co 243	58.0	11.0	1944	1945	Introduction
10.	BO 11	Co 331 X PoJ 2878	55.0	10.9	1946	1959	Developed
11.	BO 10	Co 331 X PoJ 2878	50.0	10.7	1947	1972	Developed
12.	BO 24	Co 313 x Co 356	56.0	11.2	1951	1959	Developed
13.	Co 622	Co 421 x Co331	52.0	10.5	1951	1961	Introduction
14.	BO 21	Co 313 x Co 356	52.0	10.5	1953	1959	Developed
15.	BO 22	Not available	54.0	10.8	1953	1959	Developed
16.	Co 419	PoJ 2878 x Co 290	60.0	11.0	1953	1969	Introduction
17.	BO 03	Co 312 X Co 326	55.0	10.5	1955	1977	Introduction
18.	BO 14	Co 331 X PoJ 2878	68.0	10.0	1955	1977	Developed
19.	BO 17	Co 331 X Co 326	62.0	10.0	1955	1978	Developed
20.	BO 29	BO3 F.C	60.0	10.0	1956	1977	Developed
21.	BO 32	Co 453 X BO 3	67.0	11.0	1959	1977	Developed
22.	BO 34	BO15 F.C	58.0	10.0	1959	1986	Developed
23.	BO 43	CP 28/21 X Co 285	58.0	11.0	1961	1986	Developed
24.	BO 44	Co 313 x BO 3	56.0	10.0	1961	1986	Developed
25.	Co 617	PoJ 2575 x Co 285	54.0	10.5	1961	1986	Introduction
26.	BO 47	Co 453 X BO 3	56.0	11.3	1963	1977	Developed
27.	BO 50	Co 453 X Co 513	50.0	10.8	1965	1972	Developed
28.	BO 51	Co 453 X Co 285	52.0	10.7	1965	1978	Developed
29.	BO 65	BO 14 X BO 3	58.0	10.3	1968	1978	Developed
30.	BO 70	BO 24 X BO 3	70.0	10.7	1972	1989	Developed
31.	Co1148	P 4383 x Co 301	50.0	10.3	1972	2000	Introduction
32.	Co 1158	Co 421 GC	52.0	10.5	1972	2000	Introduction
33.	BO 74	BO 14 x BO 22	55.0	10.2	1974	1978	Developed
34.	BO 75	BO 29 x BO 43	62.0		1974	1986	Developed
35.	BO 76	BO 32 Self	60.0	10.0	1974	1986	Developed
36.	CoP 1	Co 969 X CoL 9	50.0	10.8	1974	1986	Developed
37.	CoP 2	Co 419 X BO 17	50.0	10.0	1974	1986	Developed
38.	BO 84	BO 14 X BO34	52.0	10.3	1976	1986	Developed
39.	BO 88	Co 1207 X BO 47	58.0	10.8	1977	1986	Developed
40.	BO 89	BO 47 Self	60.0	10.8	1977	1989	Developed
41.	BO 90	BO 47 Self	70.0	11.0	1977	1989	Developed
42.	BO 91	BO 55 X BO 43	78.0	10.2	1978	Continuing	Developed
43.	BO 99	Co 1207 X BO 43	75.0	10.7	1978	2002	Developed
44.	BO 104	Co 1193 X BO 47	75.0	10.2	1984	1989	Developed
45.	BO 106	Co 1193 X BO 47	50.0	10.4	1984	1989	Developed
46.	BO 108	Co X 22431 FC	79.0	10.5	1984	2002	Developed
47.	CoS 767	Co 419 x Co 313	70.0	10.5	1984	2002	Introduction
48.	BO 102	BO 47F.Cs (Field Cross)	85.0	11.5	1986	2000	Developed
49.	BO 109	Co 1193 X BO 32	80.0	11.2	1986	Continuing	Developed
50.	BO 110	Co 1193 X BO 50	78.0	10.4	1988	Continuing	Developed
51.	BO 116	Co 1214 X BO 43	80.0	10.7	1989	2002	Developed
52.	BO 120	BO 91 X BO 43	85.0	11.0	1989	2004	Developed
53.	BO 128	BO 85 X BO 43	88.0	11.0	1993	2004	Developed
54.	CoP9206	CoC 671 X Co 1148	85.0	10.8	1994	Continuing	Developed
55.	CoP9301	CoC 671 X BO 99	88.0	11.0	1996	Continuing	Developed
56.	CoP9302	BO 91 X Co 62174	94.0	10.8	1996	Continuing	Developed
57.	BO 130	BO 91 X BO 43	90.0	10.5	1997	Continuing	Developed

58.	BO 136	BO 89 F.Cs (Field Cross)	85.0	10.5	2002	Continuing	Developed
59.	BO 137	BO 106 F.Cs (Field Cross)	88.0	10.4	2002	Continuing	Developed
60.	BO 138	Co 9701 X Co 1148	85.0	10.7	2003	Continuing	Developed
61.	CoP 9702	BO 99 X NC 0310	85.0	10.8	2003	Continuing	Developed
62.	BO 139	BO 109 X BO 43	84.0	11.0	2005	Continuing	Developed
63.	BO 147	BO 110 Self	88.0	11.0	2005	Continuing	Developed
64.	BO 145	BO 110 X BO 121	82.0	11.0	2006	Continuing	Developed
65.	BO 141	BO 89 F.Cs (Field Cross)	88.5	11.2	2006	Continuing	Developed
66.	BO 146	BO 128 x BO 109	92.0	11.0	2008	Continuing	Developed
67.	BO 153	BO 131 Self	87.0	10.8	2011	Continuing	Developed
68.	CoP 2061	CoLk 8102 x HR 83/65	98.0	10.5	2011	CVRC	Developed
69.	CoP 112	BO 91 x Co 62198	96.5	12.0	2015	New Variety	Developed
70.	BO 154	UP 98235 x UP 9742	104.0	11.3	2015	New variety	Developed
71.	CoP 09437	BO 91 GCs	98.0	11.2	2016	Identified	Developed
72.	CoP 16437	CoSe 92423 x Co 1148	102.0	12.0	2017	SVRC	Developed

Table 1A: Sugarcane Varieties released by SRI Pusa, Bihar since 1934 to 2019 with parentage.

(Sugarcane Varieties of Bihar – In past from 1934 to1960 there were 22 varieties release by SRI, Pusa, it was a pride period of sugarcane in Bihar, while 21 varieties released from 1960 to 1985 in next two decade from 1985 to 2005, 18 varieties and during last fifteen years from 2005 to 2019, 11 varieties released all are listed above).

Sugarcane Varieties	During the year 1934 to 2019								
	Sl. No	**1934-60**		**1960-85**		**1985-2005**		**2005-2019**	
	1.	Co 313	E	BO 43	E	BO 104	ME	BO 139	E
	2.	Co 331	E	BO 44	E	BO 106	M	BO 147	ML
	3.	Co 513	E	Co 617	E	BO 108	M	BO 145	E
	4.	Co 356	E	BO 47	E	CoS 767	ME	BO 141	ML
	5.	Co 395	E	BO 50	ME	BO 102	E	BO 146	ML
	6.	Co 453	E	BO 51	ME	BO 109	E	BO 153	E
	7.	Co 508	E	BO 65	M	BO 110	ML	CoP 2061	ML
	8.	CoK 32	E	BO 70	MS	BO 116	E	CoP 112	E
	9.	Co 383	E	Co1148	M	BO 120	E	BO 154	ML
	10.	BO 11	ME	Co 1158	M	BO 128	E	CoP 09437	ML
	11.	BO 10	ME	BO 74	M	CoP 9206	ML	CoP 16437	E
	12.	BO 24	M	BO 75	E	CoP 9301	E	Total - 11	
	13.	Co 622	E	BO 76	ME	CoP 9302	ME		
	14.	BO 21	ME	CoP 1	ME	BO 130	E		
	15.	BO 22	ME	CoP 2	ME	BO 136	ME		
	16.	Co 419	E	BO 84	M	BO 137	ML		
	17.	BO 03	MS	BO 88	M	BO 138	E		
	18.	BO 14	M	BO 89	M	CoP 9702	ML		
	19.	BO 17	M	BO 90	E	Total - 18			
	20.	BO 29	L	BO 91	M				
	21.	BO 32	M	BO 99	E				
	22.	BO 34	ME	Total - 21					

Table 1B: Sugarcane Varieties released by SRI Pusa, Bihar since 1934 to 2019.

(Symbol of Maturity E: Early; ME: Mid Early; M: Main Season; ML: Midlate).

BO 110, CoP 9206, BO 136, BO 137, BO 141, BO 146, CoP 9302, CoP 9702, CoP 2061, BO 154, and CoP 09437 are doing well in farmers field. The varieties BO 137, CoP 9301, BO 130 and BO 120 are popular for making khandsari (gur). CoP 2061 was released and notified during January 2015 while another midlate variety namely CoP 09437 was identified by CVRC, New Delhi for East U.P, Bihar, W.B. and Assam. Altogether 72 varieties were released by SRI, Pusa among them 47 BO and 25 Co and its allied varieties were released by Institute since 1934 listed in table 1. Selected best performing varieties of SRI, Pusa namely CoP 9301(E), CoP 2061(ML), CoP 112(E), BO 153(E) and 154(E) as given in table 2 which showed significant cane and sugar yield for its popularization will be done through participatory seed production involving sugarcane farmers. The varieties wise coverage area of sugarcane in Bihar during 2018 was recorded approx. 10% for CoP 9301 while CoP 2061, CoP 112, BO154 and BO 153 lies below 10%. The BO 110, BO91 and BO147 having a coverage area 20% in Bihar therefore it needs to replace by new varieties CoP 16437, CoP 112, CoP 2061, BO 154 and CoP 09437 as all of these bearing high cane and sugar yield while last three are performing very well under water logging condition. Presently new variety Rajendra Ganna-1(CoP 16437) gaining popularity among the farmers as well as sugar mills of Bihar due to its more tonnage i.e. 101 t/ha coupled with high sucrose percent 18.17% and widely adapted under changing climatic scenario of the state (Table 2). The scientists of AICRP on Sugarcane and SRI, Pusa have been continuously involved for development of improvement of sugarcane varieties and its production technologies starting from hybridization (at Coimbatore for Co clones while at Pusa for BO clones) followed by clonal selection and up to identification, release and notifications of a variety which takes 10 to 12 years. First six to seven years go for effective clonal selection of superior clones at respective research station the later half is spent on screening or evaluation of clones in comparison to the existing or ruling varieties under All India Coordinated Research Project at different locations in any particular zone and states zonal centres. After such an enormous effort a sugarcane breeder is in position to identify a promising clone that is fit to be release as a variety for commercial cultivation. The sugarcane department Government of Bihar also in favour of commercial cultivation of selected best performing 16 sugarcane varieties namely Co 98014, Co 0118, Co 0238, Co 0239, Co 0232, CoP 9301, CoLk 94184, CoS 8436,CoS 8432, CoP 2061,CoS 767,BO 153, BO 154, CoP 112, CoSe 01434 and CoSe 98259 and also provide subsidy on seed purchase during the crop season 2017-18. While in this year i.e. during 2019 only seven sugarcane variety viz, Co 0238, Co 0118, CoSe 96268, CoS 88230, CoJ 64,CoP 9301 and CoP 9301 in the place of 16 varieties of previous year. The details studies of sugarcane varieties either developed by AICRP(S) or SRI, Pusa showed significant yield and sugar potential on rest of the old non recommended varieties cultivated in sugarcane areas of Bihar now it is a good sign that Sugar Mills of the state got 10 to 11% sugar recovery in the year 2018 and even in Jan. 2019 some Sugar Mills are getting 11% sugar recovery. Best performing 4 sugarcane varieties namely Co 8014, Co 0118, Co 0238 & Co 0239 are introduced in Bihar as per the yield and sugar potential found in AICRP trial.

All India Coordinated Research Project on Sugarcane is working in the Country since 1970 through a network of Sugarcane Research Station of AICRP on Sugarcane, State Agricultural Universities (SAUs), State Government Departments and Non-Government Organizations. The project aims at pooling the research resources of the Country in a National grid for addressing the regional and national issues for improving the sugarcane production. At present, there are 22 regular centres and 14 voluntary centres across the country in five agro-climatic zones viz., Peninsular Zone, North West Zone, East Coast Zone, North Central Zone and North Eastern Zone for conducting research and multi-location testing of technology for wider adoption. Evaluation of locally adapted sugarcane varieties with improved yield and quality as well as resistance to biotic and abiotic stresses. Development of low cost technologies for sugarcane production. Intensifying and extending the networking facility and information generation for transfer of technology to the farmers and sugar industry of India are Mandates of AICRP on Sugarcane. As per the mandate, the main emphasis is laid on the development of improved varieties. After establishment of AICRP on Sugarcane in 1970, it was decided to supply fluff to the AICRP centres under "Fluff Supply Programme". Since the hybridization programme involved use of large number of parents, a National Hybridization Garden (NHG) facility was established in 1972 at ICAR-SBI, Coimbatore developed National Distant Hybridization Facility (NDHF) also at Agali, Palakkad (Kerala) where different species of *Saccharum* complex are maintained for hybridization work. These two national facilities are availed by the breeders of AICRP(S) centres for carrying out hybridization programme of their need based choice by effecting crossing NHG and/or NDHF every year. The fluff supply programme is an important component of Crop Improvement discipline as wider spectrum of genetic material is made available to the breeders. Regularly in every crossing programme Breeders of SRI, Pusa attempted the crosses utilising the wider spectrum of genetic material to full fill the objectives related development of high cane and sugar yield coupled with stress tolerance(biotic i.e. disease and pest and abiotic water logged, drought etc.) sugarcane variety for Bihar and North Central and eastern Zones. Every year, fluff of different crosses effected by the Breeders is supplied by ICAR-SBI, Coimbatore to the centres for raising of seedlings and selection of elite clones. For identification of promising crosses as per conducting zonal varietal trials, decision in first Workshop of AICRP on Sugarcane held at the Indian Institute of Sugarcane Research, Lucknow, 1970 was taken. The project on Zonal Varietal Trial (ZVT) was started by pooling the released varieties of each state in a particular zone with a view to evaluating them under varying conditions of the entire zone, so that proven varieties could be released by the other states also for commercial cultivation. The five zones identified in the country and the states included in each zone viz, North West Zone has five states Punjab, Haryana, Rajasthan, Uttar Pradesh (western and central) and Uttarakhand, North Central Zone: Uttar Pradesh (eastern), Bihar and West Bengal, North East Zone: Assam, East Coast Zone: Odisha, coastal Andhra Pradesh and coastal Tamil Nadu and Peninsular Zone: Gujarat, Madhya Pradesh, Chattisgarh, Maharashtra, Karnataka, interior plains of Andhra Pradesh, Telangana inte-

rior plains of Tamil Nadu and Kerala. After evaluation top ranking clones are being proposed by the concerned breeder for identification of variety by Varietal Identification Committee ICAR, New Delhi. The identified clones are subsequently proposed by the concerned breeder for release and notification by Central Sub-Committee on Crop Standards Notification and Release of Varieties for Agricultural Crops (Govt. of India). A total of 116 varieties have been identified since 1982 till now in different agro-climatic zones of the country. Bihar comes under North Central Zone and altogether 24 varieties were identified out of which 13 were notified for this zone. From SRI, Pusa total 10 varieties were identified viz, BO 90(E) and BO 100(ML) in 1982, BO 91(ML) in 1983, BO 109 (ML) and CoS 7918 (ML) in 1985, BO 120(E) in 1997, CoP 9103(ML) and BO 128(ML) in 1999, BO 146(ML) in 2006, CoP 2061 (CoP 06436 - ML) in 2013 and CoP 09437 in 2016 out of 10 varieties of SRI, Pusa two varieties viz, BO 128 and CoP 2061 got its notification by CVRC, New Delhi. Identified varieties from R.R.S. Motipur, Bihar (from 1985 to 2006 under SBI, Coimbatore while after 2006 to till date under IISR, Lucknow) there were six varieties viz, Co87263(E) and Co 87268 (E) in 1994, Co 89029(E) in 2001, CoLk 94184(E) in 2007, Co 0232(E) and Co 0233(ML) in 2008 after identification all these six varieties were got their notification. From GSSB&RI, Seorahi eight varieties viz, CoS 7918 (ML) in 1985, CoSe 95422(E) and CoSe 92423(ML)in 2001, CoSe 96234(E) and CoSe 96436(ML) in 2002 CoSe 01421(E) in 2009,CoSe 05451(E) in 2012 and UP 09453(E) in 2017 were identified out of which five got notification namely CoSe 95422,CoSe 92423, CoSe 96234, CoSe 96436 and CoSe 01421. Selected best performing varieties are given in table 1 for its popularization would be done through participatory seed production, especially involving sugarcane farmers.

	Variety/ Maturity		Yield t/ha.	Sucrose%	CCS t/ ha.	Recommendation either Identified or Notified	
						CVRC*/SVRC/RCM**	Area for cultivation
1.	Co98014	E	76.30	17.60	9.26	Identified and Notified*	North West Zone
2.	Co 0118	E	78.20	18.45	9.88	Identified and Notified*	
3.	Co 0238	E	81.08	17.99	9.95	Identified and Notified*	
4.	Co 0239	E	79.23	18.37	10.37	Identified and Notified*	
5.	Co 0232	E	67.82	16.57	7.83	Identified and Notified*	Bihar, U.P. W.B & Assam
6.	CoP 9301	E	83.00	18.24	10.50	Identified**	Bihar
7.	CoLk 94184	E	76.30	17.60	9.26	Identified and Notified*	Bihar, U.P. W.B & Assam
8.	CoS 8436	E	70.00	17.80	8.89	Identified	U.P.
9.	CoS 8432	E	77.00	17.12	8.36	Identified	U.P.
10.	CoP 2061	ML	74.50	17.35	9.18	Identified and Notified*	Bihar, U.P. W.B & Assam
11.	CoS 767	ML	67.85	17.98	10.41	Identified	U.P. & Bihar
12.	BO 153	E	87.00	17.42	10.44	Identified	Bihar
13.	BO 154	ML	104.00	17.47	11.97	Identified**	Bihar
14.	CoP 112	E	96.50	17.48	11.94	Identified**	Bihar, U.P. W.B & Assam
15.	CoSe 01434	E	84.20	17.60	11.41	Identified	Bihar, U.P. W.B & Assam
16.	CoSe 98259	E	78.00	17.90	10.20	Identified	U.P.
17.	CoP 16437	E	101.0	18.17	11.8	SVRC	Bihar
18.	CoP 09437	ML	96.00	17.40	10.5	Identified	Bihar, U.P. W.B & Assam

Table 2: Well performing Sugarcane varieties of AICP(S) and SRI, Pusa for commercial cultivation in Bihar.

Sugarcane varieties namely Co98014, Co 0118, Co 0238, Co 0239, CoS 8436 and CoS 8432 were exhibited good performance in North West Zone involving Punjab, Haryana, Rajasthan, Uttar Pradesh (western and central) and Uttarakhand therefore with interest of farmers and mills, introduced in North Central Zone i.e. Uttar Pradesh (eastern) and Bihar, here varieties of SRI, Pusa showed stable performance more popular in the farmers field as well as reserved sugar factories area.

Altogether development of 55 Sugarcane Clones, namely, CoP 09436,CoP 09437, BO 153, BO 154, CoP 101, CoP 11436, CoP 11437, CoP11438, CoP 11439 CoP 11440, BO 155, CoP 12436, CoP 12437, CoP12438, CoP 12439 CoP 13436, CoP13437, CoP13438, CoP 13439, CoP 14436, CoP14437, CoP14438, CoP 14439, CoP 15436, CoP 15437,CoP 15438, CoP 15439, CoP 15440, CoP 15441, CoP 16436, CoP 16437, CoP 16438, CoP 16439, CoP 16440, BO 156, CoP 17436, CoP 16437, CoP 17438, CoP 17439, CoP 17440, CoP 17441, CoP 17442, CoP 17443, CoP 17444, CoP 17445 CoP 17446, CoP 18436, CoP 18437,CoP 18438, CoP 19436, CoP 19437, CoP 19438, CoP 19439, CoP 19440 and CoP 19441 up to 2019 and most of these Sugarcane Clones were included in AICRP trials under North Central and North eastern Zones of India. After hybridization followed by clonal selection, selected 619, 666, 591, 441, 231, 441, 448 and 559 clones of Clonal generation one(C1) trials from hybrid Seedlings of the year 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019, respectively from above selected 108, 127,

Years	From Seedling generation to different clonal generations Selection of best performing clones					Best yield and juice quality Sugarcane clones Developed			Sugarcane Variety of SRI Pusa, Released/Identified	
	Seedling Raised	Selected for C_1	Selected for C_2	Selected for C_3	Selected for C_4	Total No.	Name of the clones		Inclusion in AICRP(S) trial NC & NEZ	University Research Council Meeting/SVRC for Bihar	AICRP/CVRC for East U.P, W.B., Assam & Bihar
2009	23815	423	55	38	15	04	CoP 091 & BO 153	CoP 092 & BO 154	04	BO146	---
2010	31933	536	101	48	10	01	CoP 101		---	---	BO 146*
2011	60185	768	109	32	23	06	CoP 111, CoP 112 & CoP 113	CoP 114, CoP 115 & BO 155	06	BO 153 & CoP 2061	---
2012	53431	636	145	53	19	04	CoP 121 & CoP 122	CoP 123 & CoP 124	04	---	---
2013	17458	719	127	64	23	04	CoP 131 & CoP 132	CoP 133 & CoP 134	04	---	---
2014	817 (Pusa cross)	666	154	62	18	04	CoP 141 & CoP 142	CoP 143 & CoP 144	04	---	---
2015	58509	441	108	27	13	06	CoP 151 & CoP 152	CoP 153, CoP 154, CoP 155 & CoP 156	06	BO 154 & CoP 112	CoP 2061**
2016	26824	231	173	49	18	06	CoP 16436, CoP16437 & CoP 16438	CoP 16439, CoP 16440 & BO 156	06	---	CoP 09437*
2017	40427	342	94	64	14	11	CoP 17436, CoP 17437, CoP 17438, CoP 17439, CoP 17440 & CoP17441	CoP 17442, CoP 17443, CoP 17444, CoP 17445 & CoP 17446	07	Rajendra Ganna _1 (CoP 16437)	
2018	23812	448	161	59	10	03	CoP 18436, CoP 18437 & CoP 18438	---	03		
2019	40520	559	111	82	06	6	CoP 19436, CoP 19437 & CoP19438	CoP 19439, CoP 19440 & CoP19441	-	-	

Table 3: Varietal Improvement works of sugarcane at SRI, Pusa from 2009 to 2019.

(Symbol - University Research Council Meeting**, CVRC*)

154, 108, 111, 94, 161 and 111 clones for clonal generation second (C2) in respective years, in continuation of above further selection for clonal generation third (C3) 74, 53, 64, 62, 27, 64, 59 and 82 clones were selected as mentioned above respective years presented in table 3.

Evaluation of sugarcane clone at SRI, Pusa as present research

1. Six high yielder with high sugared clones viz. POJ2878, Co285, Co281, CP28/11, Co213 & Co205 were mainly responsible for improvement in high yield and high sugar along with stable performance ability among the North Central and North Eastern Zone of Sugarcane of north India after detail studies of ancestry.
2. Evaluation of early maturing sugarcane clones - During spring season 2017 at research farm of RPCAU, Pusa the clone CoP 16437 showed highest value for cane yield and sugar yield followed by CoP15437 & CoSe12451.
3. Screening of variety under waterlogged -Four varieties viz. BO154, CoP092, CoX07067 and BO155 were identified as water-logging tolerant during 2012-13 and in another trial Evaluation of high sugared clone under water logged condition- Four clones namely CoX 12137, CoX 12164, CoX 12191 and CoX 12348 were selected as a water logging tolerant out of eighteen sugarcane clones including two checks (BO 91 and CoLk 94184) at Rajendra Agricultural University, Pusa, Bihar in a RBD with 3 replications during 2014 – 15.
4. Evaluation of early maturing clone against red rot -The clones CoX 09726 (X indicates seedling number) significantly out yielded the check variety for both cane and sugar yield. The other clones CoX 09428, CoX 09715, CoX 09547, CoX 09647, CoX 09296 and CoX 09550 were statistically at par and also showed either resistant or moderately resistant reaction against red rot disease.

5. Evaluation of sixteen early maturing sugarcane for high cane and sugar yield -Three Sugarcane Clones namely, CoP 15437, CoP 14436 and CoP 11437 were identified as high sugar and can yield bearing early maturing sugarcane during spring season 2016 these clones were planted at RPCAU, Pusa, farm Bihar.
6. Among the 15 test entries, the clone CoP16437 (Rajendra Ganna-1) showed highest value of cane yield and sugar yield followed by CoP15437 & CoSe12451 evaluated during crop season 17-18 at RPCAU, Pusa Farm.
7. Evaluation of thirteen mid late maturing sugarcane clones during 2018-19 at Research Farm, RPCAU, Pusa, Samastipur, Bihar a study on genetic variability, heritability and genetic advance for cane and sugar yield along with its component traits. Highly significant differences for all the characters were observed among the 13 clones under studied. Higher numerical values of phenotypic variances and co-variances with respect to its genotypic counterpart were recorded for all the traits indicating greater environmental influence on these traits for total variation. High heritability coupled with high genetic advance as percent of means were observed for sugar yield, cane yield, germination % at 45 days, cane height, single cane weight at harvest and fiber % at harvest, it indicates the presence of additive gene action therefore, clonal selection based on above said traits might be effective method for sugarcane improvement programme. These traits can be considered for further clonal selection and genetic improvement of mid late maturing sugarcane clones.
8. Evaluate of 18 clones during 2015-16 at RPCAU, Pusa was done on the basis of mean performance of cane yield as well as other productive traits under water logging condition, out of eighteen only four clones namely CoX 12137, CoX 12164, CoX 12191 and CoX 12348 were selected as a water logging tolerant. These clones may be utilize for further breeding programme so that recovery and productivity of sugarcane will be enhance for betterment of mankind. Aerial roots on node play important role under water logged.
9. Evaluate Sixteen early maturing sugarcane clones at Dr. R.P.C.A.U. Pusa, Bihar during 2016 found Six characters viz, cane yield, sugar yield, single cane weight, cane diameter, germination percentage at 90 days, shoots at 120 days as these characters showed high heritability coupled with genetic advance as per of mean. Well performance of the Clones namely, CoP 15437, CoP 14436 and CoP 11437 can be utilized for improvement of cane and sugar yield in early maturing sugarcane.

Improvement of sugarcane follow important considerations in choosing an appropriate variety include cane yield, juice quality, age group, suitability to the growing conditions viz., soil type, irrigation regime, season etc., ratooning potential, resistance to pests and diseases and adverse growing conditions. Some of the desirable varietal attributes one should look for are high yield potential, high sucrose content, good field appearance, higher tailoring capacity, medium thick to thick and long stalks, long internodes, erect growing habit, non-lodging, non-flowering or shy flowering, good ratooning ability, absence of spines on the leaf sheaths, absence of splits on the stalks, less bud sprouting and resistance to prevailing local problems. Varietal defects include lodging tendency, flowering propensity, disease susceptibility, cavity development, high fibre content, big and bulged buds which may be damaged during transportation, heavy spines on leaf sheath, drying of green top at maturity, tight leaf clasping, presence of heavy pith, growth cracks or splits. These defects may appear as minor and insignificant, at first, but they understandably draw the growers attention when the varieties come into cultivation. All the 14 selected early sugarcane varieties in above table showed high yield and sugar potential among them Co 0238 got popularity follow by Co 0118, Co 98014, CoP 9301 and CoLk 94184. The variety CoP 112, CoSe 01434, CoP 09437, BO 154 and CoP 16437 exhibited higher cane and sugar yield followed by suited to this zone under climatic changing scenario of Bihar, as erratic rainfall and water logging or drought condition. CoP 9301 has been found stable one and premium variety it favours more sugar and yield potential to fulfil the present need. Proper varietal proportion of area should be kept under early and mid- late maturing to ensure proper supply of cane of desired quality throughout the crushing period. Proper varietal proportion will not only increase the total sugar recovery but will also maintain it throughout the crushing season, a ratio of 60:40 has been suggested for early: mid-late ripening varieties for optimal performance and utilization of the crushing seasons. Within a maturity group, there should be more than one variety in the factory zone. It is for simple reason of providing insurance against epidemic of pest or disease of the crop, which may otherwise completely wipe out the crop. Such as Co 0238 may cultivate up to 30% coverage area of sugarcane growing area. Farmers and factory officers also encourages to increase the coverage area of Co 0238 in Bihar as they are getting more yield and sugar [9-43].

Future strategies for sugarcane research

Presently variety wise sugarcane coverage area in Bihar indicates good sign that it has been replacing old, obsolete and non recommended varieties by the improve high yielder and high sugared sugarcane varieties. During 2018 Dec., after collection of variety wise sugarcane coverage area from six sugar factories the varieties of SRI, Pusa cultivated in 24% area. Sugarcane is long duration crop maturing in 12-14 months. The planting method varies place to place and irregularity for harvesting based on maturity therefore, the states has to encourage recommended technologies and also for inter cropping to get higher returns. The main strategies to enhancing the sugar and yield potential of sugarcane in the Bihar are as under:

- Popularization of new selected varieties by providing support for breeder seed production follow participatory seed production to know the recommendations of AICRP and SRI, Pusa.
- Transfer of technologies related to mechanization and assured irrigation for sugarcane production through demonstration and training of farmers and extension workers must be updated.

- Production of quality planting materials through tissue culture plantlets and bud chip for fast multiplication must be followed.
- Training to the field functionary and farmers for popularizing various technology including Ratoon Management and recommended doses of fertilizer, insecticides, pesticides, herbicides and other updated production technologies.
- Demonstration on intercropping in which potato, wheat, pulses and vegetable crop must be grown to get extra income.
- The states have flexibility to take support for sugarcane development for any recommended/proven technology/inputs under different projects.

Selected Sugarcane Varieties for commercial cultivation includes best performing based on evaluation in AICRP trial and State trial of SRI, Pusa given in table 1 will be helpful for enhancing the sugar and yield potential of sugarcane in Bihar.

Sugar and Sugarcane yield are influenced by many factors, including changing climatic scenario, landform, soil composition and structure, irrigation and drainage requirements, varieties, pests and diseases, management skill, labour availability and harvesting methods among them role of varieties are major which needs sugarcane improvement and its popularization through participatory seed production approaches specially in the state like Bihar. Sugarcane is used as raw material for sugar mills and main product produced are white sugar and other bye products. It generates employment opportunities for over six lakh families and 50 thousand skill and unskilled factory workers. Besides, it also generate man days for weaker section of society who remain engaged in different agricultural operation on farm, final disposal at factory gate and also in small scale Gur and Khandsari industries. The cane growers of Bihar are getting more than 600 crores as price of cane used for manufacturing of white sugar, Gur and Khandsari. About 15% cane is used for seed, chewing and juice purposes. With an increase of one tonne in productivity of sugarcane, the cane grower of Bihar would be getting more than 15 crore as additional cane price. Through Bud Chip raising method 80% cane saved which will be utilised for Gur making because only buds are being used for planting with proper care. In general the seed rate of sugarcane is 50-60 quintal/ha as three budded setts used for seed. On weight basis only 15-18 kg buds are being chipped out from 100 kg of cane, it means saving of 82-85% cane value additional of Rs. 200-250 crore will be saved for planting in 2 lakh hectare.

Private Sugar factories

Sl. No	Factory	Capacity TCD	Existing capacity TCD	Cane requirement as per existing for 150 days (Tonnes)
1.	Sasamusa	1000	3500	525000
2.	Gopalganj	1200	4000	600000
3.	Sidhnealia	1000	5000	750000
4.	Bagaha	1000	5000	750000
5.	Harinagar	3000	10000	1500000
6.	Majhaulia	2000	5000	750000
7.	Hassanpur	1300	5000	750000
8.	Riga	1200	5000	750000
9.	Narkatiaganj	1200	7500	1125000
10.	Sughuli	1100	3000	450000
11.	Lauriya	1750	5000	750000
	Total	15750	58000	8700000

Sugar factories under Bihar state sugar corporation are closed since last two to four decades

12.	Hathua	2000	Closed since 20 - 40 years
13.	New Siwan	800	_
14.	Siwan	1000	_
15.	Motipur	1200	_
16.	Goraul	800	_
17.	Rayam	925	_
18.	Lohat	1320	_
19.	Sakri	762	_
20.	Samastipur	800	_
21.	Banmankhi	1000	_
22.	Bihta	1170	_
23.	Guraru	850	_
24.	Warsalinganj	700	_
25.	Morhowrah	1100	_
26.	Chanpatia	1650	_
27.	Motihari	1700	_
28.	Bara Chakia	1150	_
	Total	18227	_

Table 4: Crushing capacity and cane requirement for days of different Sugar factories.

Conclusion

From reviewed of glorious past of sugarcane in Bihar and present varietal scenario indicates a good sign for sugarcane yield and sugar production in Bihar. It was a pride moment since 1900 to 1934 that the Imperial Agricultural Institute was established in Pusa Bihar and again central sugarcane sifted at Pusa since 1936 a sum total of 281 varieties were developed by the institute among them 44 in last decade. Altogether, 72 varieties were released by SRI, Pusa among them 47 BO and 25 Co and its allied varieties, after losing resistance against disease as well as inferior performance, time to time such varieties discarded/withdrawal from commercial cultivation. Presently Co 0238 got popularity follow by Co 0118, Co 98014, CoP 9301, CoLk 94184, CoP 112, CoSe 01434, CoP 09437, BO 154 and CoP 16437 for commercial cultivation in Bihar. Several high yielder with high sucrose bearing clones after evaluation in water logging condition, red rot inoculation of early maturing are performing well and hope that in coming days further enhancement will be possible in term of cane and sugar yield for the benefits of farmers as well as sugar factories. There will be a chance with hope for opening of closed sugar mill or establishment of new one in Bihar.

Bibliography

1. Sarkar BN. "A short history of sugarcane cultivation in Bihar up to the middle of century". *Agri and Livestock India* 8.2 (1938): 167-173.

2. Indian sugar 2018-19. Anonymous, Department of Agriculture and Farmers Welfare, 2017-18.

3. Rao Bahadur B. Viswa Nath. "1935-36 Scientific reports of the Imperial Agricultural Research Institute, New Delhi, Report of the Director 1935-36". F.I.C.34-35.

4. Barber CA. "The classification of Indian Canes". *The International Sugar Journal* 24 (1922): 18-20.

5. Khanna KL. Sugarcane in Bihar: I - varietal position with special reference to procedure adopted in introducing new varieties. 8.3 (1947): 116-120.

6. Khanna KL. Sugarcane in Bihar: II- Cultural aspects. 8.3 (1947): 116-120.

7. Khanna KL. A preliminary note on the possibilities of breeding new varieties of sugarcane under North Bihar condition. Ibid., 7.1 (1937): 35-59.

8. Bakshi Ram and Rajesh Kumar. "Role of Co varieties in subtropical India". Centenary souvenir 1912-2012. (2012): 103-109.

9. Agrawal RK and Kumar Balwant. "Variability, heritability and genetic advance for cane yield and its contributing traits in sugarcane clones under waterlogged condition". *International Journal of Current Microbiology and Applied Sciences* 6.6 (2017): 1669-1677.

10. Agrawal RK and Kumar Balwant. "Characters association and their dissection through path analysis for cane and its component traits in sugarcane genotypes under water-logging condition". *International Journal of Chemical Studies* 6.4 (2018): 2327-2244.

11. Agrawal RK and Kumar Balwant. "Genetic Divergence in Sugarcane under Water- Logging Condition and Identification of Tolerant Clones". *International Journal of Current Microbiology and Applied Sciences* 6.7 (2017): 4044-4055.

12. Barber CA. "The origin of the sugar cane". *The International Sugar Journal* 22 (1920): 249-251.

13. Bal Krishna., *et al*. "Study of Genetic Variability among Mid-late Maturing Sugarcane Clones for Different Yield and Juice Quality Traits under Waterlogged Condition". *International Journal of Current Microbiology and Applied Sciences* 6.7 (2017): 1390-1397.

14. George AG and Trubnee. Bihar Peasant Life, A Discursive Catalogue (1885) george a. Grierson, trubnee and Co., 57 & 59, Ludgate Hill, London (1885).

15. Government of Bihar Department of Co-Operation and Sugarcane (Sugarcane Section) Report of the Cane and Development Committee, 1965, Printed by the Superintendent Secretariat Press, (1965).

16. Kumar Balwant., *et al*. Diversity studies in plant and ratoon crops for selection of profitable sugarcane genotypes tolerant to water logging". *International Journal of Current Microbiology and Applied Sciences* 7.8 (2019).

17. Kumar and Balwant. "Genetic divergence in sugarcane ratoon for productive traits and identification of better ratooner tolerant to water logging situation". *Journal of Pharmacognosy and Phytochemistry* 8.2 (2019): 1688-1693.

18. Kumar Praveen., *et al*. "Genetic variability, heritability and genetic advance of quantitative traits in sugarcane". *International Journal of Chemical Studies* 6.4 (2018): 3569-3572.

19. Kumar Balwant., *et al*. "Variability Studies and Frequency Distribution for Yield and Juice Quality Traits of Sugarcane Ratoon Under water logged situation". *International Journal of Chemical Studies* 7.2 (2019): 1315-1320.

20. Kumar Praveen., *et al*. "Assesment of genetic parameters for various productive traits in early maturing sugarcane". *International Journal of Current Microbiology and Applied Sciences* 7.5 (2018): 1387- 1392.

21. Kumar Praveen., *et al*. "Genetic variability study for yield and Associate characters in early maturing sugarcane". *International Journal of Current Microbiology and Applied Sciences* 7.7 (2018): 3254-3260.

22. Kumar P., *et al*. "Estimation of Extent of Variability for various traits in Sugarcane under waterlogged condition". *International Journal of Current Microbiology and Applied Sciences* 6.7 (2017): 1187-1192.

23. Kumar P., *et al*. "Study of inter-relationship and cause-effect of yield and its attribute of sugarcane under waterlogging condition". *The Bioscanean International quality Journal of Life Sciences* 12.2 (2017): 1131-1135.

24. Kumar Balwant and Pandey SS. "Association between response indices, stability parameters and their comparison for stability of sugarcane genotypes". *Journal of Sugarcane Research* 6.2 (2016): 85-99.

25. Kamat DN., *et al*. "Study of Physiological traits in Sugarcane under rainfed condition". *Indian Sugar* (2004): 985-988.

26. Kumar, Balwant., *et al*. "'CoP 112' - An early maturing and high yielding sugarcane variety for commercial cultivation of Bihar". I*ndian Journal of Sugarcane Technology* 32.2 (2017): 60-67.

27. Kumar, Balwant., *et al*. "'CoP 09437' - An identified sugarcane variety and a better option for high yielding under North Central and North Eastern Zones of India". *Indian Journal of Sugarcane Technology* 31.2 (2016): 50-54.

28. Kumar Balwant., *et al*. ""CoP 2061"- A released and notified midlate maturing sugarcane variety for Bihar, Eastern Uttar Pradesh, Assam and West Bengal". *Indian Journal of Sugarcane Technology* 30.2 (2015): 63-66.

29. Kumar P., *et al*. "Study of inter-relationship and cause-effect of yield and its attribute of sugarcane under waterlogging condition". *The Bioscanean International quality Journal of Life Sciences* 11.4 (2017): 3149-3153.

30. Kumar Balwant., *et al*. "Phenotypic stability for yield and quality in sugarcane (*Saccharum* spp.)". *Indian Sugar* 59.11 (2010): 33-37.

31. Kumar Balwant., *et al*. "Genotype X Environment interaction f and adaption in sugarcane under nort Bihar condition". *Indian Institute of Sugarcane Research* 25.1&2 (2010): 33-38.

32. Kumar, Balwant., *et al*. "Choice of ideal sugarcane clone for North Bihar". *Indian Sugar* (2006): 43-48.

33. Kumar Balwant., *et al*. "Performance of some sugarcane (*Saccharum officinarum* L.) varieties for yield and quality traits in varying environment". RAU J. Research 14.1 (2004): 12-14.

34. Neelofer Sara and Kumar Balwant. "Estimation of Variability in Red Rot Inoculated and Un- Inoculated Early Maturing Sugarcane Clones for Cane Yield and Juice Quality Traits". *International Journal of Current Microbiology and Applied Sciences* 6.10 (2017): 2347-2359.

35. Padmanbhan SY., *et al*. "Control of sugarcane seedlings disease and nematodes". Proc.29th Ind. Sc. Cong. (1942): 218.

36. Pandey SS., *et al*. "Selection of sugarcane clones under waterlogged condition in Bihar". *Indian Sugar* 60.3 (2010): 31-34.

37. Playne, S. Bengal And Assam, Behar And Orissa (1917)-Their History, People, Commerce, and Industrial Resource, The Foreign and Colonial Compiling and Publishing Co.27 pilgrim street, LONDON, EG. An account of the districts of Bihar and Patna in 1811-1812 (1917): 2 (1936) Francis Hamilton, Bihar Research Society, Patna.

38. Sethi DR and Khanna KL. "A summary of performances of some important Coimbatore sugarcane seedling in Bihar and Orissa". *Agriculture and Livestock India* 5.3 (1935): 199-217.

39. Ranjan R and Kumar Balwant. "Study of Genetic Variability for Cane Yield and its Component Traits in Early Maturing Sugarcane". *International Journal of Current Microbiology and Applied Sciences* 6.10 (2017): 1739-1748.

40. Ranjan Relisha., *et al*. "Association between different productive traits for high cane and sugar yield in early maturing sugarcane". *Journal of Pharmacognosy and Phytochemistry* 7.5 (2018): 289-295.

41. Sahu, R.S., *et al*. "Index Selection in inter varietal crosses of sugarcane (*Saccharum* spp. Hybrid.)". *Indian Journal of Sugarcane Technology* 25.1-2 (2010): 25-28.

42. Sinha SK., *et al*. "Screening of Sugarcane Genotypes for quality jiggery production and healthy life". *Society for Recent Development in Agriculture Pr. Agriculture* 15.2 (2015): 263-267.

43. Shiva Pujan Singh., *et al*. "Economics Analysis of Production, Resource Use Efficiency and Constraints Analysis of Sugarcane Cultivation in East Champaran District of North Bihar". *International Journal of Current Microbiology and Applied Sciences* 7.10 (2018): 512-519.

Assets from publication with us

- Prompt Acknowledgement after receiving the article
- Thorough Double blinded peer review
- Rapid Publication
- Issue of Publication Certificate
- High visibility of your Published work

Website: www.actascientific.com/
Submit Article: www.actascientific.com/submission.php
Email us: editor@actascientific.com
Contact us: +91 9182824667