Pakistan Sugar Journal

October-December 2011 | **Contents** | **Vol. XXVI, No.04**

Editorial Board

M. Asghar Qureshi — Chairman
Dr. Shahid Afghan — Editor-in-Chief
Dr. Muhammad Zubair — Member
Dr. Javed Iqbal — Member
Dr. Shahid Mahboob Rana — Member
MS. Asia Naheed — Assistant Editor

Published
Under the patronage of
Shakarganj Sugar Research Institute

Subscription
Dr. Shahid Afghan,
Shakarganj Sugar Research Institute
Toba Road, JHANG
Ph: 047-7652801-5
Email: shahid.afghan@shakarganj.com.pk

Subscription Rate
Pakistan Rs.300/-
OVERSEAS US$25/-

Recognized by
Higher Education Commission Pakistan

Cited by
Pakistan Press International (PPI)
Australian Associated Press (AAP)
Factiva International

ISSN 1028-1193

Panel of Referees

Dr. P. Jackson	*Principal Scientist, CSIRO, AUSTRALIA*
Dr. Benjamin L. Legendre	*Interim Director, Audubon Sugar Institute, USA*
Dr. Yong-Bao Pan	*Research Plant Molecular Geneticist, USDA-ARS, USA*
Dr. Jack C. Comstock	*Resaarch Leader, ARS USDA, Canal Point Florida, USA*
Dr. Mac Hogarth	*Group Manager BSES, AUSTRALIA*
Dr. Sizuo Matsuoka	*Director, Canavialis SA, BRAZIL*
Dr. Ruksana Bajwa	*Director, Michology & Plant Pathology University of Punjab*
Dr. Iftikhar Ahmed	*DG National Agri. Res. Center Islamabad - PAKISTAN*
Dr. Shahina Fayyaz	*Director, National Nematological Research Center, Karachi*
Dr. Irfan ul Haq	*Prof. Pathology PMAS Arid Agriculture University Rawalpindi*
Dr. S. M. Mughal	*National Professor, Higher Education Commission of Pakistan*
Dr. Asif Tanvir	*Professor, Dept. of Agronomy, University of Agriculture Faisalabad*
Dr. Aamir Ali	*Asstt. Professor, Dept. of Bio-Science, University of Sargodha*

© 2011 SSRI, All rights reserved, no part of this publication may be reproduced, stored in a retrieval1 system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without prior written permission of the Publisher.

AN ECONOMIC STUDY ON SUGARCANE PRICING AND ITS IMPACT ON SUGAR PRODUCTION IN BANGLADESH

S. Khatun,* M. Mahamudual Alam,* S. M. Khaliur Rahman** and G. M. Monirul Alam***
*Bangladesh Sugarcane Research Institute, **Bangladesh Agricultural Research Council,
***Bangabandhu Sheikh Mujibur Rahman Agricultural University

ABSTRACT

The study was conducted to determine the pricing system of sugarcane and sugar and its impact on sugar production of Bangladesh. Data were collected from secondary sources for the period of 1971-72 to 2008-09. Descriptive analysis, log linear model and Nerlovian partial adjustment model were used to analysis the data. It is found from the study that the growth rate of area and production of sugarcane, sugar, recovery of sugar and price were 1.3, 3.1, 3.0, 0.00 and 5.60 percent respectively. Study revealed that sugarcane production depends on the sugarcane area of current year and sugarcane price of previous year. The coefficients of sugarcane area and previous year price were 1.27 and 0.25 and significant at 1% level. It is also found that the price of other agricultural crops increased faster rate than sugarcane and sugar price. Procurement price of sugarcane should remunerative to keep the farmers in sugarcane production. Domestic sugar price should be reviewed compared to production cost and market price of others essential commodities.

Key words: Domestic market, growth rate, impact, jaggary price, sugarcane, sugar

INTRODUCTION

Sugarcane is the most important cash cum industrial crop in Bangladesh. It occupies forth position among the field crops and second position among the cash crops and it covers 2.05 percent of the total cultivable land. More than 0.60 million farm families are dependent on sugar industries for their subsistence. At present, 15 sugar mills are in operation under Bangladesh Sugar and Food Industries Corporation (BSFIC) with a capacity of 0.21 million tons of sugar production per year (BSFIC, 2008). These industries are providing employment for nearly 16000 persons (BSFIC, 2005). Furthermore, sugar industry plays an important role to develop infrastructure in rural areas, rural employment, income of the farm families, contribute to national exchequer, foreign exchange savings, poverty reduction and value addition to the sugar as well as by product industries (Alam *et al.*, 2005). Sugarcane is the raw material of sugar industry and the main source of white sugar and jaggary (locally called ‘gur’). Currently, on an average sugarcane is grown in 0.18 million hectare of land of which almost 50% is located in the sugar mills zone, where sugarcane is mostly used for sugar production and the remaining 50% is situated in the non-mills zone, where sugarcane is mostly used for jaggary and juice production (Anon. 1996).

Price policy is a major lever for influencing the growth of the agriculture sector. The generation of invisible surplus and its allocation and the level of agricultural income and its distribution can be influenced by agricultural price policy (Rahman, 1986). Sugarcane price is also an important factor to the farmers to allocate their land for sugarcane cultivation. In mill zone area the farmers supplied cane to the sugar mills and price of sugarcane has been fixed by the government arbitrarily and purely on the basis of weight irrespective of its quality. The success of sugar production on the part of sugar mills largely depends on successful procurement programme. In non- mill zone area, the price of sugarcane is depends on the market price of sugar and jaggary and normally it is higher than the mill zone price. Farmers are now diverting their land for other crops cultivation due to law procurement price of sugarcane in the mill zone. Hence, there is a shortage of sugarcane for cursing in the sugar mills and causing losses of the mills.

Considering these aspects, the study was conducted to analyze the pricing system of sugarcane and to find out the impact of sugarcane price on sugarcane production and sugarcane supply to the mills for sugar production.

MATERIALS AND METHODS

The study was carried out all over the Bangladesh. Data were collected from secondary sources like annual reports/ MIS reports of Bangladesh Sugar and Food Industries Corporation (BSFIC), Bangladesh Sugarcane Research Institute (BSRI), Department of Marketing (DAM), Department of Extension (DAE), different issues of Bangladesh Bureau of Statistics (BBS), USDA reports and also from internet. Data were collected during the period of 1971-72 to 2008-09 on area, production and price of sugarcane, sugar and jaggary and market price of other agricultural crops and other agro processing crops/ commodities. Descriptive statistics was used for the analysis of the data. For econometric analysis growth rate model and Nerlovian partial adjustment model were used for this study.

Analytical techniques

For growth rate analysis log linear model was used. The model was:

$\ln Y = a + \ln bt$

Where, Y = Sugarcane area, production, sugarcane supplied to the mill, sugar production, recovery and sugarcane price.

b = growth rate

t = time.

Nerlovian partial adjustment model was used for response analysis. The empirical models are:

Producers' output response model:

$Q_t = a_0 + bA_t + U_t$

Growers' sugarcane supply to the mills response model:

$S_t = a_0 + bPs_t + RPSC_t + U_t$

Sugar production response model

$Sp_t = a_0 + b_1 SPs_{t-1} + b_2 SPg_t + U_t$

Where,

Q_t = Producers' output

A_t = Area of sugarcane (ha)

St = Supply of cane to sugar mills for the period t

Ps_t = Price of sugarcane for sugar production for the period t

$RPSCG_t$ = Relative price of sugarcane for jaggary and sugar production for the period t

Sp_t = Sugar production response for the period t

SPs_{t-1} = Previous year price of sugarcane for sugar production

SPg_t = Sugarcane price offered by jaggary producers for the period t

U_t = Error term

RESULTS AND DISCUSSION

Growth Trend of Sugarcane Area, Production, Factory Supplied Sugarcane, Sugar Production, Recovery and Sugarcane Price

At present, sugarcane is grown in 153.74 thousand hectares of land producing 7098.00 and 80.00 thousand ton of sugarcane and sugar (Table-1). It is found from the table 1 that the sugarcane area and production is decreasing in different years. Sugarcane is a long durable crop and it cannot compete with other short duration high valued crops. It requires large amount of fertilizers and other inputs. Increase of fertilizer price is another reason for declining sugarcane area and production. The price of other agricultural crops increases at a faster rate than sugarcane procurement price. Moreover, the price of sugarcane and sugar becomes stagnant. These are the main reasons for declining the area and production of sugarcane. It is also observed that the growth rate of sugarcane area, production, factory supplied sugarcane, sugar production, recovery and sugarcane price were 1.3, 3.1, 2.9, 3.0, 0.0, 5.6 percent (Table-1) which is lower than other agricultural crops, the R^2 value was 0.39, 0.60, 0.29, 0.26, 0.001 and 0.86 percent respectively.

Table-1 Growth trend in sugarcane area, production, factory supply, sugar production, recovery and price of sugarcane

Crushing season	Sugarcane cultivation ('000 ha)	Production ('000 ton)	Factory supplied Sugarcane ('000 ton)	Sugar Production ('000 ton)	Recovery (%)	Sugarcane price (Taka/ton)
1971-72	55.11	1139.79	409.16	24.20	5.92	268
1972-73	47.66	1103.55	274.31	19.60	7.14	268
1973-74	56.85	2104.24	1187.20	89.81	7.56	268
1974-75	70.97	2206.10	1422.18	100.04	7.02	268
1975-76	50.54	1668.52	1100.95	88.18	8.1	268
1976-77	65.87	2389.20	1706.37	140.93	8.26	322
1977-78	96.02	3271.95	2309.65	178.07	7.72	322
1978-79	75.98	2573.83	1715.51	132.81	7.74	322
1979-80	62.97	2203.11	1272.09	94.71	7.46	322
1980-81	77.37	2833.32	1826.73	145.21	7.93	402
1981-82	94.97	3748.43	2473.30	202.16	8.17	402
1982-83	99.28	3925.14	2216.94	181.36	8.18	402
1983-84	95.90	3388.80	1899.83	151.35	7.97	455
1984-85	94.03	3136.85	1176.60	87.85	7.48	509
1985-86	73.79	2998.80	1018.20	82.50	8.11	616
1986-87	85.92	4132.37	2286.65	181.93	7.95	643
1987-88	94.30	4329.24	2199.39	178.26	8.1	643
1988-89	91.87	3767.60	1330.32	110.00	8.27	723
1989-90	85.48	4019.57	2096.20	183.86	8.77	991
1990-91	95.46	4695.51	3105.92	246.49	7.93	991
1991-92	95.50	4491.12	2390.25	195.59	8.18	991
1992-93	87.97	4246.61	2233.11	187.48	8.4	991
1993-94	92.25	4576.39	2699.90	221.55	8.21	991
1994-95	99.00	5030.45	3482.74	270.20	7.76	991

Crushing season	**Sugarcane cultivation ('000 ha)**	**Production ('000 ton)**	**Factory supplied Sugarcane ('000 ton)**	**Sugar Production ('000 ton)**	**Recovery (%)**	**Sugarcane price (Taka/ton)**
1995-96	95.94	4340.89	2383.48	183.93	7.71	991
1996-97	86.58	4097.85	1763.15	135.32	7.67	991
1997-98	88.13	4191.15	2121.85	166.46	7.84	991
1998-99	94.35	4123.74	2313.81	152.98	6.61	991
1999-00	86.40	3526.50	1612.32	123.50	7.66	991
2000-01	74.87	3361.87	1369.03	98.36	7.18	1098
2001-02	88.27	4475.99	2811.12	204.33	7.27	1098
2002-03	105.42	4595.27	2633.43	177.40	6.73	1098
2003-04	84.87	3948.24	1642.51	119.15	7.26	1098
2004-05	78.18	3516.97	1414.49	106.65	7.53	1179
2005-06	75.43	3717.30	1853.18	133.28	7.19	1286
2006-07	83.60	4112.66	2335.04	165.00	7.07	1394
2007-08	130.00	4984.00	2287.53	164.00	7.16	1420
2008-09	153.74	7098.00	1883.12	80.00	6.75	1608
Growth rate (%)	1.3	3.1	2.9	3.0	.00	5.6
R^2	0.39	0.60	0.29	0.26	0.001	0.86

Source: BSFIC, 2009.

Price is an important factor for allocating land for any crop cultivation. It is revealed from the table 2 that producer's output depends on sugarcane area and previous year sugarcane price. The coefficients of sugarcane area and previous year price were 1.27 and 0.25 and highly significant at 1% level. It indicates that if the area and sugarcane price of previous year increased 1% the output would increase by 1.27 and 0.25 percent respectively. In mill zone area normally the farmers supply their cane to the mills. But a few farmers sold their cane to the jaggary maker as they got higher prices than the sugar mills offered. Due to this reason, sugar mills became in shortage of cane crushing which resulted the lower amount of sugar production. The growers' supply of sugarcane to the mill depends on not only sugarcane price for sugar production but also the relative price of sugarcane for jaggary production. Table 2 also shows that the coefficient of sugarcane price for sugar production is positive at 5% level of significance (0.32). It indicates that holding other things remain constant, if the sugarcane price for sugar production increased 1% then cane supply to the mill would increase by 0.32 percent. On the other hand, the coefficient of relative price of jaggary and sugar production ($RPSCG_t$) is negative at 10 percent level of significance. It indicates that the ratio of sugarcane price for jaggary ($PSCg_t$/ $PSCs_t$) and sugar production increased 1 percent then the cane supply to the sugar mill would decreased 1.12 percent. It is concluded that sugar production depends on sugarcane price for sugar production and the price offered by jaggary maker. The coefficient of sugarcane price of previous years is 1.93 and positively significant at 1 % level. It indicates that if the previous year sugarcane price increased 1 percent then the sugar production would increase 1.93 percent. On the other hand, the coefficient of sugarcane price for jaggary production is 1.68 and negative at 5 percent level of significance. It indicates that if the sugarcane price of jaggary maker in the current year increased then the sugar production would decrease by 1.68 percent.

Table-2 Producer's output and grower's supply response sugarcane to sugar mill

Particulars	Estimated equation	Coefficients	R^2
Producers' Output	Q_t= -0.93+1.27A_t +0.25Ps_{t-1}	A_t =1.27*	0.91
		Ps_{t-1} = 0.25*	
Grower's sugarcane supply to mills	S_t = 12.52 + 0.32 Ps_t – 1.12 $RPSC_t$	Ps_t = 0.32**	0.34
		$RPSCG_t$= -1.12***	
Sugar production	Sp_t = 10.59 + 1.93 SPs_{t-1} – 1.68 SPg_t	SPs_{t-1} = 1.93*	0.35
		SPg_t = -1.68**	

Note: *, **, and *** indicates 1%, 5% and 10% significant respectively.

Comparison to Sugarcane and Sugar Price with Other Agricultural Crop and Agro Processing Crops

Price is an important factor of any agricultural product. In Bangladesh, agricultural prices, are increasing day by day but the deflated price of all agricultural products are being decreased. Table 3 indicates that sugarcane price was lower than other agricultural crops. From the table it also indicates that the market price of all agricultural crops during the period of 1990-91 to 2006-07 was increased but deflated price was decreased. In case of price change from the base year the price change of sugarcane was the highest negative (-53.87 %) followed by paddy (-43.78%), lentil (-38.81) and wheat (-35.01).

Table-3 Market price of sugarcane and other agricultural crops (Tk/kg)

Year	Sugarcane		Paddy		Lentil		Wheat	
	Market price	Deflated price	Market price	Deflated price	Market price	Deflated price	Market price	Deflated price
1990-91	0.99	3.01	9.00	27.39	24.43	74.36	9.10	27.70
1991-92	0.99	2.75	9.51	26.37	25.52	70.77	10.00	27.73
1992-93	0.99	2.51	8.62	21.83	25.41	64.34	8.90	22.54
1993-94	0.99	2.25	8.81	20.06	24.66	56.15	9.25	21.06
1994-95	0.99	2.05	10.71	22.21	26.23	54.39	10.71	22.21
1995-96	0.99	1.86	10.62	19.96	32.91	61.85	10.62	19.96
1996-97	0.99	1.67	9.11	15.36	36.72	61.93	9.11	15.36
1997-98	0.99	1.55	10.35	16.16	30.90	48.24	10.35	16.16
1998-99	0.99	1.41	12.40	17.71	32.64	46.61	12.40	17.71
1999-00	0.99	1.30	11.51	15.10	32.98	43.27	12.50	16.40
2000-01	1.10	1.37	11.10	13.86	32.56	40.66	12.10	15.11
2001-02	1.10	1.35	11.16	13.74	32.86	40.47	11.78	14.51
2002-03	1.10	1.33	11.94	14.45	34.42	41.65	11.94	14.45
2003-04	1.10	1.27	12.38	14.24	36.75	42.27	12.76	14.68
2004-05	1.18	1.30	12.60	13.92	38.50	42.55	12.90	14.26
2005-06	1.29	1.37	13.30	14.14	42.00	44.67	13.70	14.57
2006-07	1.39	1.39	15.40	15.40	45.50	45.50	18.00	18.00
% change from the base year	40.40	-53.87	71.11	-43.78	86.25	-38.81	97.80	-35.01

Source : Annual Report , BSFIC 2008**.**

It is observed from the table 4 that the market price of sugar, rice, edible oil and beef were increased by 35.48, 71.21, 41.74 and 206.12 percent respectively from the period of 1990-91 to 2006-07. On the other hand, it is also revealed that the deflated price of those agro- processing crops was decreased except beef. The deflated price change of sugar, rice, edible oil and beef were (-) 55.49, (-) 43.75, (-) 53.43 and 0.58 percent respectively. Among that agro- processing commodity price decreasing rate was highest in sugar followed by edible oil. It is concluded that over all price of all agricultural and agro-processing crops decreased.

Table-4 Market price of sugar and other agro- processing commodities (Tk/kg)

Year	Sugar		Rice		Edible oil		Beef	
	Market price	Deflated price	Market price	Deflated price	Market price	Deflated price	Market price	Deflated price
1990-91	31.00	94.36	12.85	39.11	53.62	163.21	49.00	149.14
1991-92	27.00	74.87	13.59	37.69	58.66	162.66	57.00	158.06
1992-93	29.00	73.43	12.31	31.17	61.62	156.03	59.00	149.40
1993-94	28.00	63.76	12.58	28.65	60.87	138.61	60.00	136.62
1994-95	29.00	60.13	15.30	31.72	65.39	135.58	60.00	124.40
1995-96	29.00	54.50	15.17	28.51	60.50	113.70	60.00	112.77
1996-97	29.00	48.91	13.02	21.96	60.41	101.89	65.00	109.63
1997-98	29.47	46.01	14.78	23.08	59.84	93.43	75.00	117.10
1998-99	29.47	42.09	17.71	25.29	64.22	91.71	80.00	114.25
1999-00	29.47	38.67	16.44	21.57	60.83	79.81	80.00	104.96
2000-01	29.47	36.80	15.86	19.80	56.84	70.97	82.00	102.39
2001-02	29.47	36.30	15.94	19.63	56.13	69.13	95.00	117.00
2002-03	28.50	34.49	17.05	20.63	63.30	76.60	100.00	121.02
2003-04	34.00	39.10	17.69	20.35	70.20	80.74	110.00	126.51
2004-05	36.00	39.78	18.00	19.89	72.00	79.57	120.00	132.62
2005-06	60.00	63.81	19.00	20.21	74.00	78.70	130.00	138.26
2006-07	42.00	42.00	22.00	22.00	76.00	76.00	150.00	150.00
% Change from the base year	**35.48**	**-55.49**	**71.21**	**-43.75**	**41.74**	**-53.43**	**206.12**	**0.58**

Source : Annual Report , BSFIC 2008**.**

Demand of Sugarcane, Sugar and Jaggary and its Shortage in Bangladesh

Sugarcane is an important food and industrial crop and the only raw material for sugar and main raw material for Jaggary industries of Bangladesh. Sugar is an important constituent of human diet. It is an indispensable item for proper activities of brain. For each person, 77 mg glucose (simple form of sugar) is required in every minute for perfect function of brain (Anon., 1957). Sugarcane is the main source of white sugar and jaggary. According to Alam, 2009 per capita availability of sugar and gur in Bangladesh were 5.8 kg and 3.0 kg as against demand of 10 kg sugar and 3 kg gur respectively. However, in India, Pakistan and Srilanka per head consumption is 20.50 kg, 19.30 kg and 12.50 kg respectively. Food and Agricultural Organization (FAO) recommends that per head annual requirement of sugar was 13 kg and accordingly for 145.91 million people annual requirement is 1.89 (2008-09) million ton. But domestic production of sugar and jaggary was 0.080 and 0.324 million tons (2008-09) respectively and imported sugar was 1.30 million ton. At present, total supply of sugar/ jaggary is 1.62 million ton and the deficit is 0.27 million ton. As a result, the people consumed less amounts of sugar and jaggary than FAO recommendation (13 kg per person per annum). The present per capita low consumption of sugar would indicate our poor profile economic status. Hence, it is necessary to produce more domestic sugar and jaggary to maintain our minimum health standard.

Table-5 Demand, supply and gap analysis of sugar and Jaggary in Bangladesh

Crushing Season	Population (million)	Demand of sugar & jaggary ('000 ton) (per capita 13 kg)	Sugar production ('000 ton)	Sugar import ('000 ton)	Jaggary Pdn ('000 ton)	SS of sugar & jaggary ('000 ton)	Shortage ('000 ton)
1990-91	109.60	1425.00	246.00	138.00	432.00	816.00	609.00
1991-92	111.40	1448.00	195.00	5.00	482.00	628.00	820.00
1992-93	113.20	1472.00	187.00	64.00	415.00	666.00	806.00
1993-94	117.70	1530.00	221.00	86.00	334.00	641.00	889.00
1994-95	119.90	1559.00	270.00	156.00	285.00	711.00	848.00
1995-96	122.10	1587.00	184.00	28.00	371.00	583.00	1004.00
1996-97	124.38	1617.00	135.00	207.00	463.00	805.00	812.00
1997-98	126.71	1647.00	166.00	160.00	415.00	741.00	906.00
1998-99	129.08	1678.00	153.00	191.00	359.00	703.00	975.00
1999-00	131.49	1709.00	123.00	115.00	427.00	665.00	1044.00
2000-01	132.00	1716.00	98.00	328.00	436.00	862.00	854.00
2001-02	133.00	1729.00	205.00	210.00	306.00	721.00	1008.00
2002-03	134.00	1742.00	177.00	600.00	322.00	1099.00	643.00
2003-04	135.20	1757.60	119.00	440.00	371.00	930.00	827.60
2004-05	137.00	1781.00	107.00	687.00	462.00	1256.00	525.00
2005-06	138.80	1804.40	133.00	625.00	333.00	1091.00	713.40
2006-07	140.60	1827.80	162.00	594.00	310.00	1066.00	761.80
2007-08	143.91	1870.83	164.00	1200.00	299.00	1499.00	371.83
2008-09	145.91	1896.83	80.00	1300.00	324.00	1624.00	272.83

Source ; BBS 1996-2008

Determination of Effective Support Price of Sugarcane

The effective support price of sugarcane for the crushing season of 2007-08 was Tk. 70.00 per mound and was determined by the total desired quantity of sugarcane in the crushing in the period 2008-09, actual supply in the period 2008-09 and price announced by the government in the period 2007-08.

Global Sugar Price and Bangladesh Sugar Industry

World sugar production for the 2009/10 marketing year is forecasted at 159.9 million tons, raw value up 11.2 million from the revised 2008/09 estimate. Consumption is forecasted at 159 million tons, up 1.5 million from a year earlier. Exports are forecasted at 51.3 million tons, up 3 million and ending stocks are forecast at 31.2 million tons, down 800,000 tons (USDA, May 2009). At present, sugar price increases sharply and becomes 580-600 dollar per ton. As a result, price of sugar per kilogram in Bangladesh increases by Taka 50-56.

S. Khatun et al.

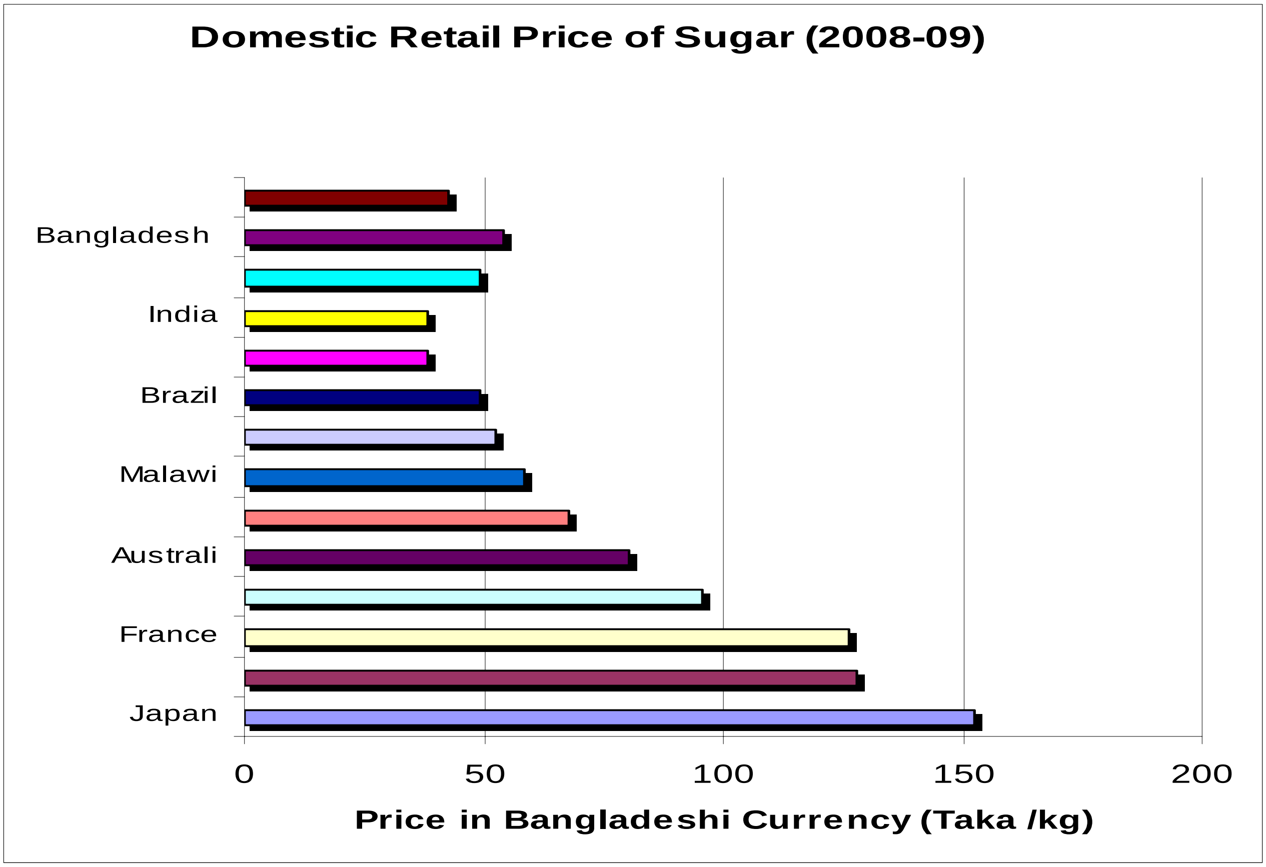

Figure-1 Domestic Retail Price of Sugar of the world (Taka/kg)

Domestic retail price of sugar in Bangladesh was lower than other countries (Figure1). The highest price per kilogram (2008-09) obtained in Japan (Taka 152.46) followed by USA (Taka 127.82) and France (Taka 126.28). During 2008-09, the retail price of sugar per kilogram in Bangladesh currency was Taka 98.00, 80.08, 60.00, 66.00, 54.00 and 42.70 respectively in UK, Australia, India, Pakistan Bangladesh and the world. The domestic price of sugar in Bangladesh was the lowest in comparison to the production cost of the domestic sugar except in the 2005-06 crushing year, which causes losses in the industry (Table 6). On the other hand, the cheap subsidized world market sugar could also incur huge losses to the industries. Further more, the preferential market price of sugar is also supported some of the ACP countries to support their industry. EU countries imported sugar with more than double price of world market from their former colony of ACP countries to develop their socio-economic condition, democracy and to establish good governess of those countries. EU-ACP signed a 'Sugar Protocol Agreement'; in Loome Convention in the year 1984, under the privileged accord the 71 ACP countries exported their fixed sugar quota to the EU preferential market with price ranging $575-600 per ton. Though EU is surplus in sugar production but sugar is imported with more than double price of the world market from these countries to help their economy. In natural disaster when sugar production has disrupts which forced the one of member of these countries unable to fill up export of sugar quota to EU, then the quota may redistribute among the member of the ACP countries or either there is a provision for shortfall country may import cheap world sugar market and it was again export EU preferential market. Bangladesh has no any sugar quota for exporting sugar in the preferential market at a higher price than world market.

Table-6 Price of Sugar in Domestic Market, World Market and Preferential Market (2001-2009)

Year	Production Cost (Taka/ton)	Domestic Price (Taka/ton)	World Market Price (CIF) (Taka/ton)	Import price (CIF) + Duties (Taka/ton)	Preferential Price (ACP) (Taka/ton)
2001-02	34290	29470	14700	24482	39200
2002-03	32920	28500	15400	25858	39550
2003-04	37320	34000	21700	31792	39900
2004-05	37000	36000	24500	36382	40250
2005-06	32000	60000	33880	52175	40600
2006-07	36000	26000	21350	24000	40950
2007-08	45000	32000	22400	29400	44660
2008-09	63000	56000	42000	45700	38500

Source: BSFIC Report (2001-2008), BBS (2006-2008), BSRI &USDA,2009.
* 1 US$ = Bangladesh Currency Taka 70.00

In November 2009, the price of sugar in international market was US$ 610 and govt. reduces import tax on refined sugar from Taka 7,000 to Taka 3,000 per ton. In the year, 2009 the retail price of sugar was Taka 56,000 per ton but production cost of sugar was Taka 63,000 per ton. The sugar industry of Bangladesh made profit in the crushing season 2005-06 due to high price of sugar in international (US$ 484) and domestic market comparison to the production cost. During 2005-06 year, sugar sold in the open market at Taka. 60,000 per ton and the production cost of sugar of BSFIC was Taka. 32,000 per ton. It indicates, only the increased sugar price in domestic market could make the industry viable.

CONCLUSION

Sugarcane is a cost intensive and long durable crop. Due to low price of sugarcane, the farmers allocated their land to other short duration crops instead of sugarcane. Price is an important factor for the farmers to produce sugarcane supply to sugar mills. In these circumstances, to make sugar industry viable / profitable government should pay a significant attention for the development of sugar industries, research and extension. Procurement price of sugarcane should remunerative to keep the farmers in sugarcane production. Domestic sugar price should be reviewed compared to production cost and market price of others essential commodities. Bangladesh Sugar and Food Industries Corporation should get responsibility to control not only importation of sugar but also fixing price of imported sugar. As a result, they will decide how much vat / tariff to be imposed on imported sugar considering the cost of domestic production. It will make the domestic sugar market more competitive. However, proper attention should be given to improve overall management efficiency for running the sugar industry in a viable condition.

REFFERENCES

1. Alam, M.M, M.I Haque, and G.M.M. Alam, 2005. Economics of Sugar Industries Performance in Bangladesh, Bangladesh J. Sugarcane. Vol. 24-27: 28-34.

2. Alam, G.M.M. 2009. Sweetening Food Security in Bangladesh: Present Situation And Future Strategy, Paper presented at the International Seminar on "Food Security and Food Safety, Towards a one world, One health approach, 17-19 March, 2009, Chittagong, Bangladesh.

3. Anonymous, 1957. The Wealth of India: Industrial Products-part IV, Councial of Scientific and Industrial Research, New Delhi, India. p. 182.

4. BBS 1996-2008. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Bangladesh.

5. BSFIC Report 1971-2008. MIS Report. Bangladesh Sugar and Food Industries Corporation. Motijhil C/A, Dhaka, Bangladesh.

6. Rahman, S.H. 1986. Supply Response in Bangladesh Agriculture. The `Bangladesh Development Studies. Vol. XIV (4): 57-98.

7. USDA. 2009. Sugar: World Markets and Trade, May 2009, USA.

INHERITANCE STUDY OF SEVEN QUANTITATIVE CHARACTERS USING NORTH CAROLINA DESIGN IN SUGARCANE

R Alam*, A.C. Deb**, M.A. Mannan*** and M.A. Khaleque****
*Scientific Officer, Bangladesh Sugarcane Research Institute, Ishurdi, Pabna,
**Associate Professor, Dept. of Genetic Engineering and Biotech., Univ. of Rajshahi, Rajshahi-6205, Bangladesh,
*** Member Director (Eco), Bangladesh Agricultural Research Council, Farm Gate, Dhaka, Bangladesh
**** Professor, Department of Botany, University of Rajshahi, Rajshahi-6205, Bangladesh.

ABSTRACT

Seven quantitative characters viz. germination percentage (Germi. %), number of tiller/clump (NT/C), number of millable cane/clump (NMC/C), cane stalk height (CSH), cane stalk girth (CSG), field brix (FB) and cane yield/clump (CY/C) were considered for inheritance study using North Carolina Design I (NCD I). In this study, ten crosses were carried out. Among the ten crosses highest 7.2 gm and the lowest 2.5 gm fuzz were produced by the cross I 34-95 x Co 642 and cross Isd 25 x I 101-66, respectively. Seedling production and its survivability was higher from the fuzz developed by the cross I 157-94 x I 101-66. From this cross, 4.4 gm fuzz produced the highest 65 number of seedlings and among these finally 49 were survived. The mean value was highly significant for all the characters indicated that the varieties were different regarding these characters. The maximum range of variation was observed for Germi. % followed by FB, NT/C and NMC/C. The magnitude of dominance component (H) was higher than that of additive component (D) in maximum cases. In the present material, both broad and narrow sense habitability were found to be low. Comparatively high genetic advance (GA) in narrow and broad senses were shown by NT/C and Germi. %, respectively. The highest genetic advance expressed as percentage of mean (GA%) was recorded for NT/C in case of narrow sense heritability and for CSH in case of broad sense heritability.

Key words: Sugarcane, heritability, additive, dominance components

INTRODUCTION

Sugarcane is a major sugar crop and is cultivated in more than 69 countries throughout the tropical and sub tropical regions of the world (Humbert, 1968). The major sugar producing countries of the worlds are Brazil, India, Cuba, China, Australia, Philippines and Thailand (Bartens, 1985). All varieties of sugarcane are species or hybrids of the genus *saccharum* of the family *gramineae*. The genus has three cultivated species (*S. officinarum*, *S. sinensis* and *S. barbery*) and two wild species (*S. spontenium* and *S. rubastum*). The tropical noble cane *S. officinarum* indigenous to the New Guinea and to thought to have been originated from wild species *S. rubastum* which is of medium thickness and low in sucrose content having chromosome number 2n = 60-148. *Saccharum officinarum* is characterized by thick stem, soft rind, high cane and sugar yield and low fibre, 2n=80, *Saccharum sinensis* and *Saccharum barberi* indigenous to north India, Bangladesh, Burma and China region (Podder, 1983). These two species are characterized by thin stalk, large vigor, wide adaptability but poor in cane yield and intermediate to low in sucrose content. *Saccharum sinensis* having chromosome number 2n= 116-118 and *S. barberi* the 2n varies from 82 to 124. *S. spontenium* the wild species is perennial, having slender stalks, high tillering capacity, high fiber and low sucrose content but resistant to most diseases. The 2n chromosome of this species varies from 40 to 128.

The aim of any plant breeding programme is to develop commercial varieties having high production potential and this potentiality of materials may be due to inherent genetic superiority of yield/quality and resistant to pest and diseases. But the success of breeding programme depends on the knowledge of genetic variability of population about the nature and different gene action governing the various qualitative traits. Yet other various models of genetic analysis of heterogeneous F2 generation maintained by random mating or open pollinated variety/population are the Comstock and Robison's (1952) North Carolina Designs (NCDs). Since the role of dominance is predominant in cross pollinated crops, a model which can measure most precisely the average degree of dominance would be the most desirable. NCDs are capable to estimating the two most crucial components, additive and dominance genetic variances which tend to define the breeding strategy for crop improvement.

Genetical work of sugarcane is a great problem due to the high polyploid number, heteroploid chromosome constitution and the difficulties involved in selfing and crossing (Bhat *et al.*, 1962). Although several information on genetical work of different crops are available in the world but it is scanty in Bangladesh. Study of "North Carolina Design I (NCD I)" in sugarcane is not also available in the world. Keeping this view in mind, present investigation was under taken to study the nature of variability and to estimate the magnitude the gene action following NCD I.

MATERIALS AND METHODS

Seedlings developed from 10 crosses using 15 sugarcane clones/varieties that are maintaining in the germplasm bank of BSRI (Bangladesh Sugarcane Research Institute), Ishurdi, Pabna were considered as the experimental materials in this investigation. The list of the clones/varieties is as follows:

Sr. No.	Clone/Variety	Sr. No.	Clone/Variety	Sr. No.	Clone/Variety	Sr. No	Clone/Variety	Sr. No.	Clone/Variety
1.	Isd 35	4.	I 101-66	7.	CPI 85-80	10.	I 205-94	13.	Isd 29
2.	I 149-00	5.	I 17-01	8.	I 34-95	11.	I 4-71	14.	Isd 25
3.	Co 642	6.	Co 1148	9.	I 157-94	12.	I 216-92	15.	I 324-86

Pollen viability of the selected clones/varieties was done before set crossing. Due to higher viability of pollen Isd 35, I 101-66, I 149-00, Co 642 and I 17-01 were considered as sire (male parents). Remain 10 plants viz. Isd 25, Isd 29, Co 1148, CPI 85-80, I 4-71, I 34-95, I 157-94, I 216-92, I 205-94 and I 324-86 were considered as dam (female parent). Each of the sires mated with two dams. All the crosses were done in crossing shed at BSRI following NCD I and was shown in Table 1.

Table-1 Pattern of crosses following NCD I

Sr. No.	Dam		Sire		Sr. no.	Dam		Sire
1	Co 1148	x	Isd 35		7	Isd 25	x	I 101-66
2	I 4-71	x			8	I 157-94	x	
3	I 34-95	x	Co 642		9	I 324-86	x	I 17-01
4	Isd 29	x			10	I 205-94	x	
5	CPI 85-80	x	I 149-00					
6	I 216-92	x						

Techniques of Analysis of Data:

The collected data were analyzed following Singh and Chaudhary, (1985) and North Carolina Design I (NCD I) of Comstock and Robinson, (1952).

For the present investigation, analysis of variance was done as per NCD I and the expectation of mean squares (EMS) are as follows:

Item	**Df**	**Mean square (MS)**	**Expected mean square (EMS)**
Blocks	b-1		
Crosses	c-1=mf-1	MS_c	$\sigma^2_w + \sigma^2_{bc} + b\sigma^2_c$
Males	m-1	MS_m	$\sigma^2_w + \sigma^2_{bf} + b\sigma^2_f + bf\sigma^2_m$
Females in males	m(f-1)	MS_f	$\sigma^2_w + \sigma^2_{bf} + b\sigma^2_f$
Blocks x crosses	(b-1)(mf-1)	MS_{bc}	$\sigma^2_w + \sigma^2_{bc}$
Blocks x males	(b-1)(m-1)	MS_{bm}	$\sigma^2_w + \sigma^2_{bm}$
Blocks x females in males	(b-1)[m(f-1)]	MS_{bf}	$\sigma^2_w + \sigma^2_{bf}$
Within crosses	bmf(k-1)	MS_w	σ^2_w
Total	bmfk-1		

Where,

b= number of blocks (replications)
m= number of males
f= number of females crossed to each male
k= constant number of individuals scored in each of the mf progeny families

From EMS of sums due to additive variance and EMS of differences due to dominance variance, additive component (D) and dominance component (H) were measured separately as follows:

(i) Additive component D:

$$1/8\ D = MS_m - MS_f/bf$$

(ii) Dominance component H:

$$1/8\ D + 1/16\ H = MS_f - MS_{bf}/b$$

(iii) The degree of dominance was calculated as follows: $(H/D)^{½}$

(iv) Heritability in narrow sense (h^2_n) and broad sense ((h^2_b) was computed as follows:

h^2_n = 1/2D/ ½ D + ¼ H)+E
(h^2_b) = ½ D + ¼ H / ½ D + ¼ H)+E
Where, E = σ^2_w - ¼ D - 3/16H

(v) Genetic Advance: Genetic advance was calculated as per formula of Lush (1949).

GA = K (σ_p) x $\sigma^2_{g/}\ \sigma^2_p$
Where,
GA = genetic advance

K = the selection differential in standard units, for the present study it was2.06 at 5% level of selection (Lush, 1949).

(σ_p) = square root of the phenotypic variance
σ^2_g = genotypic variance
σ^2_p = phenotypic variance

(vi) Genetic advance as % of Mean: It was measured by the following formula:

GA % of mean = GA/ $\bar{x}$ X 100

Where,

GA% = genetic advance as % of mean

$\bar{x}$ = grand mean for a particular character.

RESULTS AND DISCUSSION

Among the ten crosses, cross of I 43-95xCo 642 produced highest 7.2 gm fuzz followed by the cross Isd 29xCo 642, I 4-71xIsd 35 and Co 1148xIsd 35, and lowest 2.5 gm fuzz from the cross Isd 25 x I 101-66 (Table 2).

After preservation in deep fridge to control the viability, the fuzz was shown in the month of July 2005 to produce seedlings. Data of seedling germination and its survivability was presented in Table 3. It was observed from the Table that seedling production and its survivability was higher from the fuzz developed by the cross I 157-94 x I 101-66, 4.4 gm fuzz from this cross produced highest 65 number of seedlings, among these finally 49 were survived in the field.

The estimates of range and mean with standard error of seven characters are shown in Table 4. For all the characters mean value was highly significant, this indicated that the varieties were different regarding these characters. Alam *et al.,* (1978) reported a significant difference among 41 strains of *Brasica campestries* L. Considerable range of variation was observed for all the characters, the maximum range of variation was observed for Germi. % followed by FB, NT/C and NMC/C. The lowest range of variation was exhibited by CSG.

Analysis of variance was done following NCD I for seven agronomical characters are shown in Table 5. It is evident from the Table that replication x crosses, replications x males and replications x females in males interaction are found to be non significant in all the characters. But females in males interaction are found to be significant in Germi. %, NT/C, CSG and FB, and rest of characters viz. NMC/C, CSH and CY/C showed non significant when tested against within crosses. Again, males showed significant for all the characters except CY/C. Significance of males and females in males indicates substantial contribution of males and females, respectively to the variation among Bip's.

In the present study, additive (D) and dominance (H) component were estimated for their relative magnitudes. The estimated values of additive (D) and dominance (H) components, degree of dominance, narrow and broad sense heritability, genetic advances and genetic advance percentage of mean for seven agronomic characters are presented in Table 6. Table 6 showed that the magnitude of additive component (D) was higher than that of dominance component (H) only for NT/C and FB. However, dominancy was higher for rest of the characters viz., Germi. %, NMC/C, CSH, CSG and CY/C. But dominance was negative in direction for NMC/C, CSG and CY/C. These results indicated that additive component of variation was more important than the dominance component. These findings corroborated with the findings of Paul *et al.,* (1976) in rapeseed, Joarder (1978) in mustard, Hogarth (1977 and 1980), Wu *et al.,* (1980 & 1988), Skinner (1981) and Hogarth and Kingston (1984) in sugarcane. Husain *et al.,* (2000), Nahar and Khaleque (2000) and Deb (2003) also obtained similar results in their materials following TTC, Bip's and single cross analysis, respectively. In the present investigation, negative additive component was found in Germi. % and CSH. Husain *et al.,* (2000) obtained negative additive value for plant height at maximum flower in cross 1; number of secondary branches at maximum flowers in cross 1 and cross 2 and data of fruit ripening in cross 1 and cross 3. The negative dominance component in maximum cases is also supported by Moll *et al.,* (1960), Lindsey *et al.,* (1962) and Willium *et al.,* (1965) in maize, Joarder *et al.,*

(1977) in mustard, Samad (1991) in rapeseed and Nahar and Khaleque (2000) in sugarcane. Probably negative estimation of dominance component might be the genotype x environmental interaction (Hill, 1966).

The degree of dominance was measured following the ratio (H/D) ½ for the characters separately and the results are put in Table 6. It was observed from Table 6 that about 71% cases showed over dominance and rest of the cases showed partial dominance and both were in negative direction. Over dominance were found in Germi. %, NMC/C, CSH, CSG and CY/C, and FB and NT/C showed partial dominance. In some cases Samad (1991), Husain *et al.,* (2000) and Nahar and Khaleque (2000) noticed over dominance in negative direction.
Heritability estimated was computed separately both in narrow sense (h2n) and broad sense (h2b) based on components of variation of all the characters are given in Table 6. Both narrow and broad sense heritability values were low indicating that environmental variation was prevalent in this material. Singh and Singh (1972) and Singh (1973) reported generally a low estimate of narrow sense heritability for most of the characters in mustard. A low estimate of broad sense heritability was indicated by Olsson (1960) in Brassica napus for yield. Husain *et al.,* (2000) also reported low narrow and broad sense heritability in chilli. In this investigation, heritability in narrow sense was lower than broad sense in Germi. % and CSH but in other cases it is higher than broad sense.

Genetic advance (GA) and genetic advance as percentage of mean (GA%) were estimated as low both in narrow sense (h2n) and broad sense (h2b) and are shown in Table 6. In case of NT/C, NMC/C, FB and CY/C genetic advance in narrow sense was higher than broad sense. The highest GA% in narrow sense was recorded for NT/C followed by NMC/C and in broad sense noted for CSH followed by Germi. %.

Thus, the present investigation revealed that additive gene action was important in the expression of most of the characters under studied. Moreover, for five characters namely NT/C, NMC/C, CSG, FB and CY/C, which showed comparatively high above of narrow sense heritability than broad sense heritability might best be improved through pedigree selection for higher yield.

REFERENCES

1. Alam, S., M.A. Quddus and L. Rahman. 1978. Performance of locally collected mustard in relation to different genetic parameters. Bang J. Sci. Res., 1 (Part-A): 1-12.
2. Bartens, V. Dr. A. 1985. Geography of sugarcane. Berlin. pp. 387.
3. Bhat, N. R., K.S. Sybbakoo, and P.A. Kandasami. 1962. A review of cytogenetics of saccharum. Indian J. Sug. Res. Div., 7 (part -1): 1-16.
4. Comstock, R.E. and H.E. Robinson. 1952. Estimation of average dominance gene. In Heterosis, Iowa State Collage. Press, Ames pp. 494-516.
5. Deb, A.C. 2003. Study of genetic control, selection index and genotype-environment interaction of yield and yield components in Chickpea (Cicer arientum L.). Ph.D thesis, Rajshahi University, Rajshahi, Bangladesh.
6. Hill, J. 1966. Recurrent back crossing in the study of quantitative inheritance. Heredity. 21: 85-120.
7. Hogarth, D.M. 1977. Quantitative inheritance studies in sugarcane. III. The effect of competition and violation of genetic assumptions on estimation of genetic variance components. Agric. Res. 28: 257-268.

1. Hogarth, D.M. 1980. The effect of accidental selfing on the analysis of a diallel cross with sugarcane. Euphytica. 39: 737-748.
2. Hogarth, D.M. and G. Kingston. 1984. The inheritance of ash in juice from sugarcane. 1: 5-9.
3. Husain, M.M., M.A. Khaleque, and O.I. Joarder. 2000. Inheritance of yield and yield components using triple test cross (TTC) in chilli (*Capsicum annuum* L.). Bangladesh j. genet. biotechnol. 1(2): 13-17.
4. Humbert, R. P. 1968. The growing of sugarcane. Elsevier Publishing Company, Amsterdam. 1-779.
5. Joarder, O.I. 1978. Studies of the breeding of oil-seeded *Brassica campestries*. Genet. Agr. 32: 219-236.
6. Joarder, O.I., A.M. Eunus, and S. Rahman. 1977. Analysis of F_3 generation of *Brassica campestries* L. Acte Agronomica. 26: 354-363.
7. Lindsey, M.F., J.M. Lonnquist, and C.O. Gardner. 1962. Estimates of genetic variance in open pollinated varieties of corn. Crop Sci. 2: 205-208.
8. Moll, R.H., H.F. Robinson, and C.O. Cockerham. 1960. Genetic variability in advanced generations of cross of two open-pollinated varieties of corn. Agron. J. 52: 171-173.
9. Nahar, S.M.N. and M.A. Khaleque. 2000. Inheritance of some economically important characters using biparental progenies (Bips) in sugarcane. Bangladesh j. genet. biotechnol. 1(2): 23-31.
10. Olsson, G. 1960. Some relations between number of seeds per pod, seed size and oil content and the effects of selection for these characters in *Brassica. hereditas*. 46: 29-70.
11. Paul, N.K., O. I. Joarder, and A.M. Eunus. 1976. Variation of yield and some of its components in eight crosses of local and Indian rape varieties. J. Asiatic Soc. Bangladesh (Sc.). 2(1): 37-42.
12. Podder, B.P. 1983. Variability studies in sugarcane (*Saccharum officinarum*). M.Sc. thesis, BAU, Bangladesh.
13. Samad, A. 991. Genetic study and genotype-environment interaction in some agronomical characters in rapeseed (*Brassica campestries* L.). Ph.D thesis, Rajshahi University, Rajshahi, Bangladesh.
14. Singh, S.P. 1973. Heterosis and combining ability estimates in Indian mustard (*Brassica juncea* L.) Czern coss. Crops Sci. 13(5): 497-499.
15. Singh, S.P. and D. Singh. 1972. Inheritance of yield and other agronomic characters in Indian mustard (*Brassica juncea* L.). Can. J. Genet. Cytol. 14: 227-233.
16. Singh, R.K. and B.D. Chaudhary, 1985. Biometrical methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
17. Skinner, J.C. 1981. Application of quantitative genetics of breeding of vegetatively reproduced crops. J. Aust. Inst. Agric. Sci. 47: 82-83.
18. Willium, J.C., L.H. Penny, and G.P. Sprague. 1965. Ful-sib and half-sib estimates of genetic variances in open pollinated varieties of corn (Zea-mays). Crop Sci. 5: 125-129.
19. Wu, K.K., D.J. Heinz, H.R. Meyer, and S.L. Ladd. 1980. Combining ability and parental evaluation in five selected clones of sugarcane (*Saccharum* sp. Hybrids). Theor. Apple. Genet. 56: 241-244.
20. Wu, K.K., D.J. Heinz, and D.M. Hogarth. 1988. Association and heritability of sugarcane smut resistance to race A and B in Hawii. Theor. Apple. Genet. 75: 754-760.

Table-2 Performance of crosses to produce seeds (fuzz)

Sr. No.	Parentage		Type of cross	Fuzz collected (gm)
	Dam	Sire		
1.	Co 1148	Isd 35	Marcot Cross	5.0
2.	I 4-71		Marcot Cross	6.0
1.	I 34-95	Co 642	Marcot Cross	7.2
2.	Isd 29		Marcot Cross	7.0
1.	Isd 25	I 101-66	Marcot Cross	2.5
2.	I 157-94		Marcot Cross	4.4
1.	CPI 85-80	I 149-00	Marcot Cross	3.3
2.	I 216-92		Marcot Cross	4.4
1.	I 324-86	I 17-01	Marcot Cross	4.2
2.	Isd 31		Marcot Cross	4.0

Table-3 Development of seedling from fuzz and its survivability

Crosses		Quantity of fuzz sowing (gm)	No. of seedling germinated	Seedling survived in nursery	Seedling transplante d in field	Seedling survived in field
Dam	Sire					
Co 1148	Isd 35	5.0	57	40	40	35
I 4-71	Isd 35	6.0	15	14	14	11
I 34-95	Co 642	7.2	33	27	27	25
Isd 29	Co 642	7.0	21	17	17	14
CPI 85-80	I 149-00	3.3	23	21	21	18
I 216-92	I 149-00	4.1	41	33	33	32
I 157-94	I 101-66	4.4	65	52	52	49
Isd 25	I 101-66	2.5	28	20	20	17
I 324-86	I 17-01	4.2	19	16	16	14
Isd 31	I 17-01	4.0	23	20	20	18

Table-4 Ranges and means with standard errors of seven agronomical characters in sugarcane

Characters	Range	Mean with standard error
Germi. %	30.38 – 59.17	40.7499 ± 1.6239
NT/C	2.70 – 5.93	4.446 ± 0.1657
NMC/C	2.14 – 5.35	3.5535 ± 0.1146
CSH	2.05 – 2.99	2.4914 ± 0.0564
CSG	1.74 – 2.22	2.0236 ± 0.0101
FB	11.05 – 18.62	15.3526 ± 0.1510
CY/C	1.55 – 3. 78	2.8479 ± 0.0882

Table-5 Analysis of variance for seven agronomical characters in sugarcane following NCD I

Item	df	Germination %		NT/C		NMC/C		CSH		CSG		FB		CY/C	
		SS	**MS**	**SS**	**MS**	**SS**	**MS**	**SS**	**MS**	**SS**	**MS**	**SS**	**MS**	**SS**	**MS**
Replications	2	244.2876		1.09125		1.1817		0.2865		0.0154		2.0542		0.701	
Crosses	9	780.576	86.7296	17.2456	1.9161	12.033	1.337	2.4443	0.2715	0.2163	0.0240	39.135	4.3483	9.0312	1.0034
Males	4	339.476	84.8697*	12.5546	3.1386**	10.5031	2.6257**	1.0067	0.2516**	0.1764	0.0441**	25.7296	6.4324**	7.5600	1.8900 NS
Females in males	5	441.1037	88.2207**	4.6909	0.9381**	1.5298	0.3059 NS	1.5610	0.3122**	0.0399	0.0079 NS	13.4059	2.6812*	1.4711	0.2942 NS
Replications x crosses	18	396.377	22.0209 NS	3.6678	0.2037 NS	3.8175	0.21208 NS	0.2064	0.0114 NS	0.0602	0.0033 NS	27.6578	1.5365 NS	2.0101	0.1116 NS
Replications x males	8	223.9394	27.9924 NS	2.1345	0.2668 NS	2.4159	0.3019 NS	0.0476	0.0059 NS	0.0355	0.0044 NS	9.4665	1.1833 NS	1.2892	0.1611 NS
Replications x females in males	10	172.4376	17.2437 NS	1.5333	0.1533 NS	1.4016	0.14016 NS	0.1588	0.0158 NS	0.0248	0.0024 NS	15.4109	1.5411 NS	0.7209	0.0720 NS
Within crosses	270	7157.4563	26.5091	105.4831	0.3906	106.1792	0.3932	6.1434	0.0227	2.4411	0.0090	334.4388	1.2387	330.9675	1.2258
Total	299														

*, ** and NS indicates significant at 5% and 1% level and non significant, respectively.

Table-6 Estimates of additive (D) and dominance (H) components, degree of dominance $(H/D)^{½}$, narrow sense (h^2_n) and broad sense (h^2_b) heritability, genetic advance (GA) and genetic advance as percentage of mean (GA%) for seven agronomical characters in sugarcane

Components	Germi. %	NT/C	NMC/C	CSH	CSG	FB	
D	-4.4680	2.9336	3.0928	-0.0808	0.0480	5.0016	
H	387.4800	-1.6816	-5.3024	1.7424	-0.0672	-3.9227	
$H/D^{½}$	-9.3125	-0.7571	-1.3093	-4.6437	-1.1832	-0.8856	
h^2_n	-0.0077	0.3235	0.3234	-0.1279	0.2443	0.1867	
h^2_b	0.3283	0.2307	0.0504	1.2581	0.0733	0.1135	
GA_n	-0.3808	1.4508	0.9286	-0.3419	0.1348	1.3840	
GA_b	16.2391	1.0346	0.1447	3.3469	1.9975	0.8414	
$GA\%_n$	-0.9344	31.6837	26.1319	-13.7232	6.6650	9.0151	
$GA\%_b$	39.8506	22.5944	4.0720	134.3381	1.9975	5.4805	

RATOON PERFORMANCE OF SUGARCANE VARIETIES UNDER SOUTHERN PUNJAB CONDITIONS

Muhammad Aslam* Muhammad Tauseef* Abdul Rasheed Zahid** M.Jamshed Anwar***
* Sugarcane Research Station, Khanpur, ** Sugarcane Research Sub Station, Bahawalpur
*** Oilseeds Research Station, Khanpur

ABSTRACT

Thirteen new promising sugarcane varieties viz CPHS.35, S2000US.50, S2001US.71, S2001SP.104, S2002US.36, S2002US.92, S2002US.116, S2002US.133, S2002US.162, S2002US.454, S2002US.619, S2002US.635 and CPF.246 were evaluated for their ratoon yield and quality against a commercial cultivar SPF.234 as check under Southern Punjab conditions during 2007 at Sugarcane Research Station, Khanpur. The variety CPF-246 on account of high number of sprouting per plant (1.57), significantly higher 100-cane weight (95.67 kg), highest millable cane count (112.69 thousand ha^{-1}), maximum cane yield (107.90 t/ha) and comparable CCS% (12.74) against check SPF-234, produced the highest sugar yield of 13.74 t/ha. It was followed by S2002US.619. CPF.246 on the basis of 26.07, 1.35 and 26.75 % more ratoon cane yield, CCS and sugar yield, respectively over control is capable of replacing the check variety and can make gigantic strides in sugarcane production for sweet revolution. A wide scale testing in various agro-ecological zones is, however, invited for regional adaptability.

Key words: Varieties, Ratoon Potential, commercial cane sugar, millable cane, sugarcane.

INTRODUCTION

In sugarcane cultivation, ratoon keeping is a common established practice and major priority of growers. Only a good ratooner sugarcane variety gains popularity among the farming community. Ratoons are cheeper to grow about 30-40% due to saving in soaking irrigation, land preparation, cost of seed and sowing operations (Akhtar *et al.*, 2003). Ratoon crop occupies 35 to 50 % of the total cane area in Pakistan (Malik and Guman, 2005).

Afzal *et al.*, 1990 studied the ratoon performance of six sugarcane varieties and reported maximum average cane yield of 75.55 t/ha for CP-43-33. The same variety surpassed in sugar yield. El-Geddawy *et al.*, 2002 elucidated that sugarcane variety GIT-54-9 significantly surpassed the other varieties in respect of stalk height, stalk diameter and stalk weight in both ratoon crops. Rafique *et al.*, 2005 carried out two years field experiment to investigate ratooning potential of ten sugarcane varieties and concluded that CPF-243 and HSF-240 gave significantly more yield during both years of study. Bashir *et al.*, 2007 undertake a field study on ratooning ability of spring planted sugarcane varieties and observed that maximum cane yield was produced by CPF-237 and HSF-242 of ratoon crop. Jamil *et al.*, 2007 evaluated the ratooning behavior of 22 candidate sugarcane varieties under NUYT programme. Findings of the study revealed that promising sugarcane varieties S95HS.185, S97US.183, S96SP.302, CPHS.35, NSG.311 and Malakand 16 were better ratooners. Khan *et al.*, 2007 indicated that sugarcane variety S96SP.302 produced significantly maximum ratoon cane yield of 79.39 t/ha against the lowest cane yield of 41.94 t/ha recorded for NSG-311. The higher cane yield was mainly associated with higher number of millable canes, cane height, and cane girth. Therefore, a study was planned in this context to asses the comparative ratooning performance of candidate sugarcane varieties under Southern Punjab conditions.

MATERIALS AND METHODS

The field experiment was conducted under irrigated conditions during spring season to evaluate the ratoon potential of elite sugarcane varieties during 2006-2007 at Sugarcane Research Station, Khanpur. The experiment was started during 2006 when the plant crop was sown on 18th February. The crop was harvested in the first week of February, 2007 and kept as ratoon. The verities included in the study were CPHS.35, S2000US.50, S2001US.71, S2001SP.104, S2002US.36, S2002US.92, S2002US.116, S2002US.133, S2002US.162, S2002US.454, S2002US.619, S2002US.635, CPF.246 and SPF.234 The experiment was laid out in Randomized Complete Block Design with three replications. The sugarcane genotypes were sown by dry method in 120cm apart trenches with a net plot of size 3.6 × 10 m using a seed rate of 75000 double budded sets per hectare. The ratoon crop was fertilized at the rate of 218-146-146 kg NPK per hectare, respectively. After harvesting the plant crop, uneven stubbles were cut manually with the help of hand chopper. Then interculture was given to control weeds, loosen the soil to help root development and thus facilitate sprouting. Afterwards, whole of P, K and 1/3 of N was applied to the crop followed by irrigation. The remaining 2/3 N was given in two equal splits, 1/3rd N was given at completing sprouts (60 days after harvesting of plant crop) and 1/3 during the second fortnight of May when crop was earthed up. Meanwhile data on number of sprouts per plant were recorded. The data on cane density, weight, yield and quality were recorded at the harvest during the last week of December 2007. The data thus recorded were analyzed using Analysis of variance techniques and Least significance difference test was applied to compare the treatment means (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Number Of Sprouts Per Plant

The sprouting of underground buds plays a pivotal role in the establishment of an economical ratoon sugarcane crop. Climatic conditions, soil moisture and vigor of plant crop play a very important role in determining the final harvest of ratoon crop. It is evident from the data given in table-1 that there were significant differences in the number of sprouts per plant produced by different sugarcane varieties under study. The standard sugarcane variety SPF-234 produced the highest number of sprouts per plant (1.61). It was, however, matchingly followed by CPF-246, S2002US.619 and S2002US.92. These differences in the number of sprouts per plant may be attributed to the varied inherent ratooning potential of the varieties (Rafique *et al.*, 2005).

Cane Weight

The individual cane weight is a very important yield contributing character, which directly affects the final yield. The data presented in the table-1 show significant differences in the 100-cane weight given by different genomes. Promising sugarcane variety CF-246 produced the heaviest canes (95.67 kg per 100 canes). It was, however, matchingly followed by S2002 US.92 and CPHS.35. The lowest 100-cane weight of 71.33 kg was recorded for S2002US.162 preceded by S2001US.71 and S2002US.36. These differences in the stalk weight may be attributed to the varied genetic potential of tested sugarcane clones.

Cane Density

Adequate number of potentially heavy millable canes ensures high yield. The establishment of millable canes is direct reflection of stubble sprouts in ratoon crop of sugarcane if tiller mortality remains the same. The data compiled in table-1 depict that the candidate variety CPF-246 produced significantly more number of millable canes against all other varieties under investigation (112.69 thousand ha $^{-1}$). It was followed by S2001SP.104 and S2002US.619, which were at par with each other by establishing a cane density of 99.54 and 99.26 thousand canes per hectare, respectively. The thinnest stand of 55.09 thousand cane stalks was recorded for S2002US.162, which was non-significantly preceded by S2002US.116.

The differential behavior of sugarcane genotypes for the production of variable number of millable canes may be attributed to the varying inherent potential of different genetic make ups to exploit environmental resources.

Stripped Cane Yield

Economically high cane yield is the ultimate goal of every grower which is function of the well coordinated inter play of genetic constitution and the environment to which it is exposed. Different yield attributes like number of millable canes, cane height, cane girth and thus per cane weight have direct bearing in the final stripped cane yield per unit area. The data embodied in the table -1 indicated that the tested strains differed substantially in final cane yield. The promising sugarcane variety CPF-246 gave significantly highest ratoon cane yield of 107.90 t/ha. It was followed by S2002 US.619 and SPF-234 with a final tonnage of 92.41 and 86.27 per hectare which were at par with each other. Afzal *et al.*, 1990, EL-Geddaway *et al.*, 2002, Rafique *et al.,* 2005, Bashir *et al.,* 2007, and Jamil *et al.*, 2007 have also reported the varied tonnage of stripped canes for different genotypes.

Sugar Yield

The underlined goal of all efforts made by a breeder as well as Agronomist is the attainment of higher tonnage of crystal sugar which is actually made in the field and collected in the factory. It is evident from the data given in table-1 that all the varieties / promising clones under study behaved differently from one another for the production of sugar yield. The highest sugar yield of 13.74 t/ha was produced by the promising clone CPF-246, closely followed by S2002US.619 and SPF.234. The least amount of white sugar (4.76 t/ha) was recorded for S2002US.116. This differential behavior of sugarcane varieties / strains to produce sugar yield may be attributed to the variability in their genetic constitution to exploit environment.

REFERENCES

1. Afzal, M., S. Bashir and R.M.A. Khan. 1990. Influence of harvesting dates on ratoon cane crop. Pak. Sugar J., 4(4): 23-25.
2. Akhtar, M., M.Ashraf and M.E.Akhtar.2003.Sugarcane yield gap analysis: Future options for Pakistan. Sci.Tech.& Develop.I: 38-48.
3. Bashir, S., A. A. Chattha, M. Afzal, J. Iqbal and M.Z.Khan.2007.Studies on the ratooning ability of different sugarcane varieties of different harvesting dates.Proc. 42nd Ann.Con.Pak.Soci.Sug.Tech.27-28 Aug.PP.170-182.
4. El-Geddawy, I.H., D.G. Darweish, A.A. El-Sherbiny, E. Eldin and A.El-Hady.2002. Effect of row spacing and number of buds/seed sett on growth characters of ratoon crops for some sugarcane varieties. Pak. Sugar J., 17(3): 7-14.
5. Jamil, M., S. Afghan, M.A. Majid and A.Rasool.2007. Ratooning performance of sugarcane varieties. Pak. Sugar J., 22(3): 38-47.
6. Khan, N., G. Rasool, M.A. Aunjam, K. Masood and A. Bakhsh 2007. Ratoonability of different sugarcane candidate varieties under agro-ecological conditions of D.I. Khan. Proc. 42nd Ann.Con.Pak.Soci.Sug.Tech.27-28 Aug.PP.103-9.
7. Malik, K.B. and M.A.Gurmani.2005.Cane production guide. My choice printing press, Hyderabad.PP.55.
8. Rafique, M., A.A. Chattha, A. Jabbar, G.M. Wains, M.U. Chattha, M. Yasin and M.A. Munir. 2005. Proc. 40th Ann.Con.Pak.Soci.Sug.Tech.5-7 Sept..PP.195-202.
9. Steel, R.G.D. and J.H.Torrie.1984. Principles and procedures of Statistics. 2nd Ed., Mc. Graw Hill Book Co., Inc., Tokyo,PP.107-09.

Table-1 Ratoon performance of sugarcane varieties under southern Punjab conditions

S. No	Variety	Sprouts Plant $^{-1}$	100-cane weight (Kg)	Cane density 000/ha	Cane yield (t/ha)	CCS %	Sugar yield (t/ha)
1	CPHS.35	1.35c	93.33ab	90.83bc	84.72bcd	11.71	09.92
2	S2000US.50	1.25d	89.00abc	89.07bc	79.72cde	11.84	09.44
3	S2001US.71	1.15e	75.00ef	82.87cd	62.41fg	10.96	09.84
4	S2001SP.104	1.51b	80.67de	99.54b	80.65cd	11.21	09.04
5	S2002US.36	0.74g	75.678ef	70.00e	53.06gh	12.24	06.49
6	S2002US.92	1.54ab	94.33ab	74.72de	70.56ef	10.07	07.11
7	S2002US.116	0.75g	79.33de	56.48f	44.42hi	10.63	04.76
8	S2002US.133	1.05f	92.33abc	86.26e	79.64cde	12.97	10.33
9	S2002US.162	1.19de	71.33f	55.09f	39.26i	12.10	04.75
10	S2002US.454	1.23de	90.00abc	84.26c	75.75de	10.96	08.30
11	S2002US.619	1.57ab	93.67ab	99.26b	92.41b	12.41	11.46
12	S2002US.635	1.34c	88.00bc	80.28cde	70.65ef	12.74	09.00
13	CPF.246	1.57ab	95.67a	112.69a	107.90a	12.74	13.74
14	SPF.234	1.61a	89.00abc	96.94b	86.27bc	12.57	10.84
LSD 0.05		1.09	6.71	10.65	9.87	---	---

Values with different letter(s) differ significantly (P=0.05)

Announcement:

The Sugar Processing Research Institute 2012 Conference will have as its theme: **"Sugar And Bio-products: International Research Needs For the Future".**

The conference will be held **March 11-14, 2012,** in New Orleans, Louisiana, USA, at the Chateau Bourbon Hotel in the famous "French Quarter".

Sessions will include ***process improvements, bio-product development, and sweetener usage.*** The conference will include **t*echnical presentations, commercial presentation, a sugar forum and a technical tour.***

The agenda, reception and banquet along with the meeting location insure that not only will there be an informative meeting but also one where delegates can truly enjoy the venue and partnership with fellow delegates.

For further information on presenting papers and posters and to receive registration information, please contact Sugar ***Processing Research Institute, Inc. (SPRI), 1100 Robert E. Lee Blvd., New Orleans, Louisiana 70124,***
phone: 504-286-4343, fax: 504-282-5387 or
E-mail address: spri@ars.usda.gov Website: www.spriinc.org

SUGAR INDUSTRY ABSTRACTS

*Shahid Afghan & M. Pervez Akhtar
Shakarganj Sugar Research Institute, Jhang, Punjab, Pakistan

Sugarcane Mechanisation for profitability and sustainability under environmental conservation
C. Norris, P. Lyne and K. Choonhawong
Agricultural Engineering, Proc. Int. Soc. Sugar Cane Technolo., Vol 27, 2010 pp.15

The paper summarises the findings compiled from contributions of the committee members and from the proceedings of the International Society of Sugar Cane Technologists (ISSCT) Agricultural Engineering Section Workshop held between 3rd and 5th of March 2009 at The University Centre, Kamphaeng Saen Campus at Nakhon Pathom of the Kaestart University, Thailand. The opening addresses gave an excellent overview of the Thailand industry, which globally is the second largest exporter of sugar, and has over 80% of its farms of less than 20 ha in size. The industry is in a stage of rapid development, with appropriate mechanization for small growers being a significant issue. The demand for by-products such as ethanol are significant catalysts for the growth of the industry. The presentations were grouped under the general headings of machinery and mechanisation and management and logistics, with a focus on mechanization associated with smaller operations. The field visits associated with the workshop focused on the very significant development which is occurring in appropriate mechanization for small and medium size growers, as well as the integration of rotation crops with sugarcane and irrigation systems used. In the workshopping sessions, a wide range of issues were discussed, ranging from Crop Production to the Environment, Miller-Grower Politics and Health & Safety issues were also seen as issues which could be addressed, with discussion on the potential of ISSCT sanctioning various training courses. Overall, the most significant issue seen to be facing the industry was logistics and cost of cane transport from the field to the mill. Thailand represented an excellent venue for the workshop, because of its rapid growth and the market driven development of appropriate mechanization for small growers.

Study on farmland application of vinasse from sugarcane molasses
Chen Yan and Shinogi Yoshiyuki
Agriculture Engineering, Proc. Int. Soc. Sugar Cane Technolo. Vol 27, 2010 pp.16

During bio-ethanol production from sugarcane molasses, large amounts of vinasse, which is strongly acidic with high COD and BOD, is produced as a by-product. Disposal of vinasse is one restrictive problem for sustainable bio-ethanol production. In this study, possible application of vinasse to farmland was investigated. First, the staple characteristics of vinasse were determined. Second, availability of nutrients such as nitrogen and potassium to crops and dynamics in the soil environment were studied in the laboratory and thirdly, crop growth experiments were carried out in the field.

In conclusion: Potassium is the most common nutrient in vinasse; Large amount of chloride are also present;
High COD and pigment from rind of sugarcane were also observed.

Farmland application of vinasse as a substitute for one third of the potassium showed no significant damage to the growth of red-radishes and tomatoes. When large amounts of vinasse are applied to farmland as a substitution for the nitrogen in traditional chemical fertilizers, nitrogen deficiency symptoms, especially immediately after application, are expected. In addition, it is necessary to take into consideration the leaching of ions and the pigment in the vinasse for proper timing of application and soil conditions.

Use of vinasse for soil reclamation and its impact on elemental loads in vertisol soil and groundwater

Marco Antonio Giron Tejada
Agronomy, Proc. Int. Soc. Sugar Cane Technol., Vol.27, 2010 pp.25

A study was carried out to evaluate the contamination of soils and groundwater through the use of vinasse in the reclamation of saline soils with trace elements such as Fe, Cu, Mn and Zn to sugarcane soils. The soils at the experimental site were located in the flat area of Valle del Cauca, Colombia and consisted of the Vertisols of the Galpon series characterized with a loam clay texture and problems of salinity and sodicity. Vinasse containing 10% total solids was applied at the rate of 1500 m^3 /ha. The trace element contents in the soil increased compared to their initial values but did not reach levels that are considered as deleterious to the soils. Similarly, the concentration of trace elements in groundwater was not significantly increased and remained below the threshold values according to the Colombian environmental legislation. In conclusion, in this type of soil there no contamination problems with heavy elements in soil and groundwater from the application of vinasse with 10% solids on the reclamation of saline soils.

Concepts and value of the nitrogen guidelines contained in the Australian sugar industry's six easy steps nutrient management program

B.L. Schroeder, A.P. Hurney, A.W. Wood, P.W. Moody and P.G. Allsopp
Agronomy, Proc. Int. Soc Sugar Cane Technolo. Vol. 27, 2010 pp.26

The Australian sugar industry currently faces unprecedented scrutiny of its use of nutrients due to initiatives to protect the Great Barrier Reef from excess nutrients and sediment from agricultural activities along the Queensland coast. However, this quest needs to be viewed in conjunction with the need for a sustainable sugarcane industry. A comprehensive program for nutrient management (the SIX EASY STEPS program) has been developed recently for the Australian sugar industry. It replaces the previous general guidelines that did not differentiate between regions or soil types and lacked precision. The new system supports profitable and sustainable sugarcane production enhances environmental awareness, and is consistent with best practice. The paper summarises the alternative N management strategies that occur within the Australian sugar industry. It describes best-practice nutrient management and the concepts that underpin the SIX EASY STEPS program, and explains the principles of the N management guidelines used within the SIX EASY STEPS program and link this to N use efficiency. It also assesses the value of the SIX EASY STEPS N guidelines are robust and much more in line with the concept of sustainability than any of the other strategies considered. Calculation of the target N-use efficiency factors across the full range of SIX EASY STEPS N guidelines, especially when all possible sources of N within the soil/plant environment are included, strengthens the SIX EASY STEPS as an appropriate and fully comprehensive nutrient management package. This is confirmed by the results of the economic analyses of data from both small plot experiments and commercially-based replicated strip trials conducted on-farm.

Genetic base broadening of sugarcane (*saccharum ssp*.) by introgression of genes through intergeneric hybridization

K. Shanmugha Sundaram, M. Krishnamurhi, S. Rajeswari, Shini Sekar and M. Shanmuganathan
Breeding, Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010 pp.67

Sugarcane (*Saccharum* spp) is one of the crops for which interspecific hybridisatation has provided a major breakthrough for its improvement. However, intergeneric hybridisation has been gaining importance to broaden the genetic base and to obtain commercially useful traits and simultaneously increase the total biomass. The benefits derived from the use of wild species like *S. spontaneum* have been realized since the early 1900s, and compatibility of *Saccharum officinarum* with Erianthus is now being explored to incorporate disease-resistance genes. This genus also has a great potential for vigour, better ratoonability and tolerance to environmental stresses. In E.I.D. Parry (India) Ltd, R & D Centre, attempts were made through a conventional breeding program to introduce these traits into commercial sugarcane cultivars. The true nature of these bybrids is confirmed by morphological features like leaf orientation, leaf striping, stalk length, stalk thickness, internode length, stalk colour and bio-chemical features like sucrose, fibre content and analysis through molecular techniques. Selected intergeneric bybrids were used for backcrosses to develop commercial cultivars.

Identifying quantitative trait alleles for physiological traits in sugarcane an exploratory study

A. Singels, M.A. Smit, M.K. Butterfield, P.D.R. Van Heerden and M. Van Den Berg

Breeding, Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010 pp.68

This study attempted to shed light on the feasibility of high throughput phenotyping of physiological traits and the detection of quantitative trait alleles (QTA) for these traits. Stalk elongation rate per unit thermal time before and after the 14 leaf stage (SER_{14} and SER_{24}), leaf appearance rate per unit thermal time (LAR_{14} and LAR_{24}), fully expanded leaf area per leaf (LA) and photochemical light use efficiency (PI_{ABS}) were measured for 80 clones of a mapping population in three experiments conducted at Mount Edgecombe, South Africa. Within-experiment clonal repeatability was highly significant for all traits. Inter- experiments correlations show that SER_{24}, LA and PI_{ABS} were reasonably stable across experiments. Significant single marker-trait associations were found for all traits and multiple marker-trait associations explained from 39% (six QTAs to predict LAR_{24}) to 55% (five QTAs to predict SER_{24}) of clonal variance. However, the low number of markers detected in all three experiments cast doubt on the reliability of marker-based predictions for LAR_{14}, LAR_{24} and $SER_{24.}$ Results indicate that LA and PI_{ABS} were reasonably stable across environments and can be predicted reliably from genomic information. $PI_{ABS,}$ as estimated through rapid, non-destructive chlorophyll a fluorescence measurements, in particular shows great promise because it has the potential for high throughput phenotyping at an early stage in the plant life cycle. The promising results obtained here suggest that further research is warranted in refining experimental protocols and validating marker-trait associations in other germplasm and environments. This could pave the way to explore the exciting possibilities that gene-to-phenotype modeling offers for enhancing sugarcane breeding.

Monitoring the severity and variability of brows rust (*Puccinia melanocephala)* in sugarcane varieties in the cauca valley, Colombia

Juan C. Angle, Andres, F. Gutierrez, Jershon Lopez-Gerena, Maria L. Guzman, Lina M. Cardona and Jorge I. Victoria

Pahtology, Proc. Int. Soc. Sugar Cane Technolo. Vol.27, 2010 PP.126

The varieties CC 85-92 and CC 84-75 are grown on more than 80% of the area planted with cane in the Colombian sugar industry; these varities were initially resistant to brown rust disease. Brown rust has been present in Colombia since 1979. Genetic variability in *Puccinia melanocephala* is thought to have affected resistance in some varieties through the appearance of what are thought to be new races of the pathogen. The situation has been observed in some resistant varieties (e.G. CC 85-92, CC 84-75, CC 93-3895), where recently the disease has occurred at low severity. Therefore, an evaluation was made of the severity and possible variability of brown rust in the varieties selected by CENICANA in the Cauca River Valley, Samples were taken from plants from 1-14 months of age in the varieties CC 84-75, CC85-92, CC93-3895, CC92-2804 and MZC 74-275 on 91 estates (10 sugar mills). On each plantation 20 talks were selected at random, and the third leaf from the top visible dewlap leaf was taken from each stalk. Both disease reaction and severity were evaluated. Morphological and microscopic analyses of the structures found in the rust

pustules were undertaken in leaf samples taken from each variety. Simultaneously, pathogen samples were collected and molecular techniques used (focusing on initiators of the ribosomal DNA (rDNA) to detect possible genetic variation of *P. melanocephala*. The results showed that the disease reaction type in the varieties evaluated was 5 or less, with severities ranging from 0-12% leaf area affected. Variety MZC 74-275 showed susceptibility, with a reaction of 6 and a severity of 20% on the estates where it was evaluated. No differences were found among the morphological structures in the samples evaluated, all of which corresponded to *P. melanocephala*. The results obtained from the amplification of he ITS1 and ITS2 regions of the rDNA and from PCR-RFLP did not show differences among the samples evaluated. These results could indicate that the variation of the pathogen is not reflected in its rDNA or that the molecular technique used was not sufficiently sensitive to detect small variations in the genome. Initial results about the presence or absence of gene Brul and susceptibility to brown rust are discussed.

Root and basal stem rot disease of sugarcane in lampung, Indonesia
Remaja Sitepu, Sunaryo, Koko Widyatmoko and Heri Purwoko
Pathology, Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010 PP.127

The root and basal stem rot disease is new to Indonesia. It was detected in 1993 on a commercial variety grown in Gunung Madu sugarcane plantation, Lmpung. Infected plants have been more frequently found thereafter on newer varieties and the disease is becoming more important to the plantation. Based on field observations, the infection in contaminated fields may reach 11% stalk infection. Symptoms appear on mature plant crops (9 month and older), and on younger plants in ratoon crops (5 month and older), as yellowing or drying of cane leaves. Under very severe infection, the symptoms could be visible much earlier and may be followed by patches of dying stools across the field. Because of the rotten roots and basal stem, the infected plant is easily pulled out of the ground. The key indicator of the infection is the emergence of multiple branched stroma that protrude from the ground around the cane stool, and from the dead stubbles. In general, the disease characteristics are very similar to the root and basal stem rot disease reported from Taiwan. The CABI identification services, England, upon examination of the anamorphic and teleomorphic states of the causal pathogen, has almost certainly confirmed that the causal pathogen in Indonesia and Taiwan in similar, namely *Xylaria* cf. warburgii. Yield loss assessment conducted on artificially inoculated plant crops in the field revealed that at 25-26% infection severity the particular disease could potentially reduce the cane and sugar yield by 12.3% and 15.4% respectively.

Improving productivity in sugar mills by integrating co-products utilization
M. Enriquez Poy and R. Prado
Co-Products, Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010 PP.140

This paper shows an 'incentive program' for workers, through one model of development, using mainly co-products of sugarcane; used in different ways in Granja Teresita, 25 kilometers from the mill. This mill has a plant to hydrolyse bagasse in two batch reactors by a physical process (using steam at 1.4 MPa) and areas for composting residuals (90 days, without enzymatic process), and sell the production to the ranch. For cattle and goats, we use the cane tops with molasses, hydrolysed bagasse, wet fibre cane 'cush- cush' separated in clarifier filters, and other agriculture residuals of the region. For pigs, invert 'B' molasses and some locally produced complements are used. For sustainable agriculture, organic fertilizer compost, produced locally, are used with lamb manure. A range of crops is grown including corn and sorghum and horticultural crops, and there is also an aquaculture industry.

EPA Challenges for bagasse fired power stations

M.B. Inkson, B.J. Misplon and E. de Villiers

Co-Products: Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010 PP.141

Traditionally, the sugar industry has been treated leniently with respect to emissions standards but, as it focuses more on electricity as a profitable by-product, which is changing even though bagasse is a renewable fuel. Nowhere is that more the case than at US Sugar's Clewiston factory in Florida: even though it is not a major exporter of electricity, when it installed a new boiler, the factory was obliged to conform with stringent EPA standards. The challenges imposed by the standards are discussed together with the engineering solutions and the results obtained. The outline specification was for a 500 000 lbs/h [~226 800 kg/h] boiler delivering 600 psig, 750^{0}F [~4137kPa, ~399^{0}C] steam when firing bagasse. The main challenges were seen in obtaining the 0.026 lbs/MMBTU [~24 mg/Nm^3] PM_{10} limit and the original 0.12 lbs/MMBTU [~70 ppmvd] NOx limit without exceeding the 0.38 lbs/MMBTU [~363 PPmvd] CO limit or the 20 PPmvd ammonia slip limit. Continuous monitoring was required. Engineering was supported by fluid dynamic studies, in particular with respect to the NOx and CO profiles in the furnace: i) maximum NOx reduction was required from the urea injection system so location was critical; and ii) engineering down combustion NOx increases CO. In the event, the unit comfortably passed all tests. The available OFA nozzles, which had been installed, proved particularly useful in tuning the boiler and the low uncontrolled NOx levels [meaning there will be reduced urea charges] were pleasing to see. While these stringent requirements are unlikely to be applied to other bagasse boilers in the short term, the lessons will make it possible to rise to those challenges when they arise.

INSTRUCTIONS FOR AUTHORS

Dear Fellow Author(s),

Please follow these instructions for publication of your research papers in PAKISTAN SUGAR JOURNAL (PSJ). It will help editorial board to review your articles immediately. Otherwise, it will be delayed to fulfill the prerequisites for publication of research paper(s):

- Write the title of your article in CAPITAL LETTERS in the center of the page
- Write the complete name of all authors with their addresses, its compulsory
- In the text, references should be cited by author and years as, for one, two or more authors (Hammer, 1994, Hammer and Rouf, 1995; Hammer et al., 1993), respectively.
- Write HEADINGS in bold letters and in the center of the page.
- Type your article only in TIMES NEW ROMAN format.
- Send TABLES 0f FIGURES on separate page with bold title and mark its numbers correctly.
- Follow the following rule for Reference, For one author: Hussain, K. 1991 for two authors; Khan, M. and A. Habib 1995, for more than two; Ali, K., A. Hussain and S. Nasir. 1990
- Always send two soft copies and one hard copy of CD. Please don't use FLOPPY for this purpose
- Send copies on A-4 size page preferable LASER PRINT in word document
- PSJ publishes paper free of charges from authors
- Kindly send your papers to following address by mail or email.

Dr. Shahid Afghan
Director Research
Editor-in-Chief Pakistan Sugar Journal
Shakarganj Sugar Research Institute, Jhang (Pakistan)
Phone: +92 47 765 2801-5 Ext. 602 & 603
Mobile: +92 312 382 0837
Email: shahid.afghan@shakargnaj.com.pk

Ms. Asia Naheed
Assistant Manager
Assistant Editor
Pakistan Sugar Journal
Shakarganj Sugar Research Institute, Jhang (Pakistan)
Phone: +92 47 765 2801-5 Ext. 606 & 603
Email: asia.naheed@shakarganj.com.pk