(Revised)

HOW TO INCREASE SUGAR YIELD PER HECTARE

by

Karim Bakhsh Malik,

R and D Advisor

Abdullah Shah Ghazi Sugar Mills, Garho

Introduction

Next to cotton, sugarcane has the largest industrial base in agricultural sector of Pakistan. For the last 2-3 seasons economic viability of Pakistan sugar industry is at stake. Low market prices of sugar do not match the higher prices of sugarcane. A number of sugar mills are at the verge of insolvencies. The reason for this situation can be analyzed from the production cost of sugar.

A Layman's Analysis of Production Cost of Sugar

The data is presented to show the impact of sugar recoveries on the production cost of 100 maunds cane at the market prices of Rs. 50, 55 and 60 per Kg. Sugar (**Table-1**).

Table-1: A layman's analysis of production cost of sugar

Sugar Rec.	Sugar produced from 100 maunds cane		Cost on 100 mds cane	Income from sale of sugar at three rates: Rs. Per Kg.		
%	Mnds	Kg.	17,200	50	55	60
9.0	9.0	360	Minus loss due to 3 % trash -518 = **16,684**	12,960	14,616	16,272
9,5	9,5	380		13,680	15,428	17,176
10.0	10.0	400		14,400	16,240	18,080
10.5	10.5	420		15,120	17,052	18,984
11.0	11.0	440		15,840	17,864	19,888
11,5	11,5	460		16,560	18,676	20,792

- Deductions:

1. Sale tax @ 8% on sale price of sugar sale.
2. Loss due to weight of trash (3%) = Rs 516 per 100 maunds cane.
3. Milling & processing cost @ Rs. 10/- per kg sugar.
   Considered on negotiations with concerned persons of various sugar mills; it varied from Rs. 7/- to Rs. 10/-.per maund.

The data in **Table-1** indicate that the Sugar mills having sugar recovery around 11.5 % are in a position to market sugar at Rs. 50 per Kg., while sugar mills having recovery of less than 9.5%

are entirely at loss, even at market price of Rs. 60 per Kg. sugar. Eventually, higher recoveries fetch considerably better cash returns than lower recoveries. It thus indicates that **Economic viability of sugar industry is mainly affected by sugar recovery.** Where our sugar industry stands can be checked from the **Table-2**:

Comparing production cost of sugar in Table-1, the economics of the sugar industry can be adjudged from the recoveries obtained by various sugar rmills. So as to sustain the economic growth of the industry sugar mills recoveries have to be increased

Table -2. Periodic sugar recoveries of different sugar mills during 2014-15

Sugar Mill	Nov	Dec	Jan	Feb	Mar	Average
Mehran	-	10.57	11.17	11.77	12.42	11.42
JDW	-	10.47	11.06	11.51	11.78	11.16
Matiari	-	10.13	10.92	11.18	11.57	10.52
HSM	-	9.39	10.46	10.91	10.90	10.40
Dewan	-	9.16	9.58	10.35	11.47	9.95
Ittefaq	8.07	9.37	9.34	9.51	9.91	9.94
Haq Bahu	-	9.74	9.62	10.08	9.94	9.80
Chenar	8.10	8.97	9.34	9.69	10.19	9.37

Factors Affecting Sugar Recoveries

1. Growing high sugar varieties
2. Fertilizer management - Balanced dose of fertilizer
3. Irrigation management
4. Reducing losses in cane sugar recovery
5. Reducing losses in milling and processing
6. Cane procurement strategies
7. Cane payment policies

1. Growing High Sugar Varieties

Cane variety is the single most dominant factor in improving sugar mills recoveries. A number of high sugar varieties have been released by Sugarcane Research Institutes, during the past decades.

- **Main varieties under cultivation in Sindh**

BL 4, Triton, BF 129, Th. 10, SPSG 26, NIA 2004, HS 12, SPF 234, CPF 237, CPF246

In Abdullah Shah Ghazi Sugar Mills, Bl 4, Triton and BF 129 are the main varieties under cultivation. Since their recoveries are low, average recoveries could not be enhanced to desired level. Efforts were made to collect most promising varieties from different Research Stations for screening and selection under local conditions; the **45** varieties so collected were planted at Madina Agri. Farm, Ghorabari, during October, 2013(Table-3). The laboratory tests were performed for assessing their juice quality in the sugar mills from October 20 to November 21, 2014, the data for which is reproduced in Table-4.

Table 3. Introduction of new cane virilities at Madina Agri. Farm

Source	Varieties introduced	Total
SRI, Faisalabad	CPF 237, CPF 246, CPF 247, HSF 242, US 272, US 469, US 633, US 658, US 824, AUS 134, AUS 133, AUS 138, SP 18, SP 30, SP 93, CP 77-400	16
SCRI, Thatta	Th 127, Th 311, Th 318, Th 326, Th 344, Th 409, Th 910, Th 2109, YT 53, YT 55, BL 4, BF 129, Triton	13
SSRI, Jhang	CSSG 676, CPSG 12, HOG 33, CSSG 2416, CSSG 2453, CPSG 2713, CPSG 2923	7
NIA, Tando Jam	NIA 2004, NIA 12, NIA 13	3
HSM, NWS	HS 21, HS 22, HS 24, HS 32, HS 98	5
NARC, ISD	NARC 2	1
	Total	45

The data in Table-4 represents the average Brix, Pol, Purity and Sugar recovery contents recorded for multiple samples during 20th October to 21st November, 2014. It could be noted that a number of cane varieties have shown sugar recoveries over 11 percent during October-November period against 8.5% in our existing cultivars. With advance in maturity period the varieties are likely to reach a recovery level of 12.5 to 13.0%. In case these varieties are get adapted and multiplied on a large area, can bring revolution in this tract.

Table-4. Quality performance of cane varieties planted at Madina Agri. Farm, (20 Oct-15 Nov)

S No.	**Variety**	**Brix**	**Pol**	**Purity**	**S. Rec.**	Samples
1	**Th 2109**	21.70	18.80	86.77	12.06	5
2	**AUS 133**	21.26	18.16	85.33	11.52	4
3	**CSSG 676**	20.99	17.63	84.03	11.24	7
4	**Th 326**	20.85	17.40	83.49	11.19	4
5	**Th 910**	20.40	17.29	84.69	11.16	5
6	**NIA 13**	19.12	16.31	85.31	11.15	1
7	**AUS 138**	20.51	17.42	84.93	11.01	5
8	**CPF 247**	19.38	16.45	85.07	10.99	2
9	**CPF 237**	20.07	16.83	83.79	10.72	7
10	**YT 53**	19.96	16.95	84.88	10.71	3
11	**US 824**	20.67	16.93	81.93	10.63	4
12	**Th 344**	20.09	17.04	84.32	10.60	1
13	**CPF 246**	19.97	16.56	82.90	10.42	8
14	**Th 127**	19.26	16.39	85.11	10.38	1
15	**NIA 12**	19.16	15.75	82.34	10.29	2
16	**Th 311**	18.36	15.47	84.26	10.29	2
19	**YT 55**	19.89	16.33	82.07	10.08	2
20	**Th 318**	18.99	15.55	81.92	9.97	2
23	**US 658**	19.05	15.56	81.65	9.84	4
21	**BL 4**	19.45	15.71	80.84	9.60	4
22	**AUS 134**	18.76	15.22	81.08	9.82	4
24	**NIA 2004**	20.04	15.98	79.51	9.67	2
25	**BF 129**	17.47	14.28	81.74	8.79	2
26	**Th 409**	17.68	13.34	75.20	8.10	2
27	**Triton**	16.84	12.55	74.52	7.69	2

The data in Table-4 show the cane yield parameters' of some of the selected varieties. It indicate the potential of cane growth and yield in this cane field. We have plans to multiply these varieties at growers' fields in the season to come.

Table-4 Cane yield and quality parameters of some promising varieties

S.No	**Cane variety**	Cane stalk			Cane quality			S. Rec%
		Length (Ft)	Thickness (cm)	Weight (Kg)	Brix	Pol	Purity	
1	**Th-2109**	9' - 7"	2.88	1.68	22.46	19.54	87.00	12.55
2	**Th-910**	8'- 7"	2.84	1.31	21.86	19.26	88.11	12.47
3	**AUS-133**	11'- 8"	2.86	2.22	22.42	19.55	87.20	12.50
4	**AUS-138**	10'- 5"	2.74	2.15	22.36	18.95	84.75	11.96
5	**CSSG-676**	11' - 2"	2.81	2.20	21.66	18.65	86.10	11.90
6	**US-824**	9' - 8"	2.56	1.45	20.79	16.97	81.63	10.44
7	**CPF-237**	9' - 2"	2.65	1.54	21.06	18.03	85.61	11.46
8	**CPF-246**	10' - 3"	2.82	1.92	21.06	17.56	83.38	10.96

A View of New Cane Varieties

US-658 CPF 246 TH 2109

A View of New Cane Varieties

CSSG 676 CPF 237

2. Fertilizer Management

Fertilizer, its dose and time of application to the crop has a leading role in enhancing or reducing sugar recoveries. It must be applied in a balanced dose of N P and K. Balanced fertilizer dose for Pakistan conditions has been worked out as under.

Fertilizer requirements of cane:

	N	P	K
Kg per ton of cane	1.20	0.46	1.49

The generalized recommended dose is 2 bags of DAP, 2 bags of Potash and 2 to 3 bags of urea. But unfortunately, our growers pay least attention to the recommended doses. Usually DAP is applied almost half the recommendations, Urea rather more than the recommendation and K application is altogether avoided. Only quite a few growers take pain but at half the rate. The importance of the balanced doses can also be checked from the NPK requirements of cane in other countries (Table-5).

Table-5. Fertilizer requirements in some other countries

'K' Nutrients required per ton of cane			
N	**P2O5**	**K2O**	**Reference**
1.83	0.70	2.12	Naido etal, 1999 (India)
2.50	0.50	2.75	Hunsigi, 1993 (India)
1.54	0.37	2.76	Calcino, etal, 2000 (Australia)
1.20	0.46	1.49	Anon, 2003 (Pakistan)

Nitrogen Management

'N' fertilization delays maturity:

- If applied in excess of the required dose

  And if applied late
- The excess N make room for uptake of more moisture, that too delays maturity
- For inducing maturity 'N' must be exhausted by the end of growth period
- Symptoms: leaves turn pale yellow.

‘K’ Essential for Crop Maturity

It must be realized that ‘K’ has very important role in synthesizing sugars in plants and its storage in cane stalk.

Important functions

- Help in chlorophyll synthesis
- Translocation of sugar from leaves to sites of storage in cane stalks
- Regulates uptake of ‘N’ and its utilization by plants
- In ‘K’ deficient plants, ‘N’ accelerates growth and plant do not tend to maturity

In view of the facts given above the Potash fertilizer must be applied as per recommendations. The sugar recovery can also be improved by spray application of ‘K’ fertilizer (Table-6).

Table-6. Sugar yield as affected by foliar spray of potassium, 60, 90,120 DAP.

Spray treatment	Sugar yield tha^{-1}
Potassium Chloride @ 2-5%	6.93
Potassium Chloride + urea 2.5% each	7.47
No spray	6.60

3. Irrigation Management

Irrigation management, during various growth stages, is a main tool to improve cane yields. During growth stages the objective is to improve biomass through accelerated vegetative growth. With onset of maturity period irrigation is controlled to check vegetative growth and reduce excessive moisture in cane stalks and leaves. To achieve crop maturity there are certain parameters to be observed.

- Irrigation to cane crop to be withheld 3 weeks prior to harvesting. This is practiced to reduce leaf sheaths moisture from 82-85 to 72-73%.
- No of leaves per plant must be reduced: From 12-15 to 6-8 leaves.
- Leaf color is the indicator of leaf moisture and cane maturity. Crop not to be harvested with dark green leaves. Crop to be harvested when cane leaf color changes from dark green to pale yellow

Observations on the impact of leaf sheath moisture and leaf color on juice Brix is given in **Table-7.** These observations ere recorded in cane fields of Habib Sugar mills area. Color observations we rerecorded in various fields, leaf sheaths of the concerned crop were cut wrapped in plastic bags, clipped in pieces n the laboratory, weighed on electronic balance and kept in a convectional oven at 65^{o} C for draying at constant weight. Observations are as per recommendations.

The data indicate that the samples showing green color of leaves with leaf moisture around 78% show juice Brix of 18-19^{o} while pale green color with leaf moisture less than 75 show brix figure of 20-23^{o}.

Table-7. Leaf color an indicator of leaf moisture and crop maturity

S.No.	Cane variety	Leaf moisture %	Leaf color	Brix
1	SPF 234	78.74	Green	18.19
2	SPF 234	78.51	Green	19.25
3	SPF 234	79.88	Green	19.30
4	SPF 234	74.33	Light green	20.25
5	SPF 234	69;64	Pale dry	21.50
6	HS 12	74.05	Green	20.40
7	HS 12	75.44	Green	20.30
8	HS 12	75.07	Green	20.20
9	HS 12	73.80	Pale	22.25
10	HS 12	68.84	Pale	21.22
11	HS 12	73.76	Pale	23.20

4. Reducing Losses in Sugarcane Recoveries

- Losses due to presence of trash in cane
- Losses due to post harvest staling in cane
- Losses in milling and processing operations

Losses Due to Cane Trash

In normal practice sugarcane harvested from the cane field should be de-trashed and quite clean cane to be supplied to sugar mills. Unfortunately sometimes things get out of the control of sugar industry staff and cane is supplied partially and sometimes completely with trash. The composition of trash varies from 1 to 20 percent. The sugarcane supplied with trash induces two types of losses to sugar industry.

- Extra payment on the weight of cane trash
- Reduction in sugar recover during mill processing\

  This exercise is conducted considering 3% trash brought to the factory with cane.

Trash Weight

- Cane supply: 100,000 maunds
- Includes trash weight @ 3% trash: 3000 mds
- Payment to grower on the weight of trash

  @ Rs. 172/- per maund: Rs. 516,000
- **Loss per maund of cane: Rs. 5.16**

Loss in Sugar Recovery

- One percent trash reduces Sugar recovery by 0.12 unit,

  so 3% trash losses by 0.36 units
- Cane Supply: 100,000 maunds
- Actual crushing: 100,000-3,000 maunds as weight of trash =97,000 maunds
- Sugar loss : 97,000 x 0.36% = 349.2 maunds
- Financial loss @ Rs. 55 per Kg sugar.= Rs. 768,240
- **Loss per maund of cane : Rs. 7.68**
- **Total losses;** (trash weight and sugar recovery) **= Rs. 12.80 per maund of cane**

Cane fully covered with trash and being supplied to a sugar mill

Post Harvest Staling Losses

Supply of stale cane has become a great menace in Pakistan sugar industry. In most of the cases It takes 3-4 days to complete harvesting for one trolley/truck load of cane for supply to sugar mills. In case there is rush on cane carrier it may take further 24- 48 hours to wait for unloading. This staling causes considerable losses in sugar recovery. The sugar mills face two types of losses.

Two fold losses

Loss in cane weight: due to moisture loss and drying

Loss in sugar recovery: due to biochemical changes in cane juice

Main causes

- Over harvesting – unplanned or undirected
- Large sized trolleys – takes more days to complete load for haulage to sugar mills.
- Unavailability of vehicles for cane transport
- Sugar mills shut down-occasional

The post harvest staling data shown in **Table-8** indicate that after 96 hours of harvest CCS dropped by 1.38 units. Simultaneously, the cane juice undergoes deterioration, showing a rise in invert sugar from 0.65 to 1.06. The magnitude of loss is worked out to be Rs. 27.94 per maund of cane crushed.

Table-8. Post harvest sugar recovery losses - 96 hours after harvesting

Month	CCS %		Reducing sugars	
	Initial	Fall	Initial	Rise
November	8.46	1.11	1.20	0.60
December	9.42	0.52	0.78	0.46
January	10.90	1.16	0.43	0.91
February	11,84	1.04	0.41	1.17
March	12.8	2.40	0.46	1.38
April	12.94	2.04	0.62	1.82
Average	**11.06**	**1.38**	**0.65**	**1.06**

Post harvest staling losses

- CCS loss (average) = 1.38
- Sugar recovery loss= 1.27 %
- Cane Weight = 100,000 maunds
- Sugar loss = 1270 maunds
- Value f sugar @ Rs. 55/- per Kg = Rs. 2,794,000
- **Financial Loss per maund of cane: Rs. 27.94**

How to avoid Post harvest staling losses?

- Should use vigilance in cane supply permit. Cane supply permit = for within 24 hours crushing.
- Cane harvesting and supply to correspond with crushing capacity of mills.
- Harvesting program of growers to be watched.
- Proper education to growers on quality cane harvesting.
- Sugar mills to have prompt cane transport system. Should arrange flat of trucks/ trolleys to meet full cane procurement requirements.

5. Reducing Losses in Milling and Processing

The Pakistan sugar industry depicts a sugar recovery loss of about 2.5% during its milling and processing operation. Though there are units showing losses of less than 2% and more than 2.5%. It means the margin for recovery improvements is around 0.7º. On the other hand margin for improvement in sugar recoveries due to improved varieties and planting practices is 2.5 units.

- Scope for reducing losses in the factory = Existing 2.5% loss can be reduced to 1.8 %
- **Scope for improving recovery in a factory = 0.7 units**
- Scope for improving recovery in cane field = Existing 9.5% can be increased to 12.0 %.
- **Scope for improving recovery in cane field = 2.5 units**
- Production cost ratio in cane : sugar = 65 : 35; Cane has more share, so should need more attention.

The point of concern is that the industrialist is not paying due attention make improvements in cane fields.

- **The owner's Tendency to invest for improvement:**

  In the factory = always inclined/ready

  In the field = always reluctant

  For bringing improvement in sugar recoveries the mills owners shall have to review their priorities

6. Cane Procurement Strategies

- Cane department should be vigilant about its cane quantum in mills zone and around.
- Cane staff should be aware of cane variety position in different sectors
- In its cane procurement programme preference should be given to high sugar early maturing varieties.
- For cane purchase middlemen in no case be involved. This group is least concerned about quality of cane.
- While making cane procurement, targets should be the maximum sugar recovery and not the maximum cane weight, during the season.

7. Cane Payment Policies

- It pertains to the cane price linked to cane quality or flat rate.
- At present we have flat rate system, the minimum fixed by the GOVT.
- The cane price should be one that assures some incentives to cane growers.
- There could be two systems:
- Cane price linked to market price of sugar, and worked out according to sugar recoveries of individual consignment; as prevailing in most of advanced countries.
- The other option is the incentive on the average sugar mills recovery for the season.
- The system has already been approved for Pakistan as well and has been operative for a number of years in Punjab.
- But unfortunately due to some mistrust of both millers and growers the matter is held in abeyance by the Supreme Court. This policy should be revived.

Conclusion

- The economic viability of Pak sugar industry is at stake due to low sugar prices against higher prices of cane.
- Economic viability of the sugar industry can be enhanced by the increase in sugar recoveries and reducing the sugar losses in cane.
- The sugar yields are enhanced by judicious application of irrigation and balanced dose of fertilizer so as to attain peek maturity in time.
- Attention should be focused to meet the required dose of ‘K’ nutrients
- The sugar recoveries are improved by propagation of high sugar varieties.
- Efforts should be made to bring maximum area under early maturing high sugar varieties.
- The sugar industry should support growers to propagate high sugar varieties.
- A profitable sugar harvest programme can be launched when harvest initiates with 10% recovery in Oct and terminate the season with over 12% recovery n March. This can be achieved by growing high sugar varieties and harvesting according to cane maturity.
- In order to maintain a desired recovery level sugar losses due to trash and post harvest staling should be minimized.
- A well planned cane procurement programme is a key to the success of profitable harvesting.
- For bringing improvement in sugar recoveries the mill owners shall have to change his priorities.
- Incentives on quality varieties assure the adoption of good sugar varieties leading to economic viability of sugar industry