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Myths Within the Sugar Industry

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Every day in a cane sugar factory, management faces decisions that will affect recovery and quality of sugar made. Some of these decisions are based upon manufacturing conditions while others are based upon economic return. This paper deals with "Myths" or "Misconceptions" within the cane sugar industry which hamper recovery.

During my 39 years of working and consulting within the cane sugar industry, I have found these "Myths" interfere directly with decision making and positive change. This is a short collection of anecdotes that define some of these "Myths":

- **"The purpose of a commercial enterprise is to convert resources into wealth".**

(Dr. Stephen J. Clark)

This is the key concept every manager and supervisor must take into account on a daily basis. The sugar factory may make a variety of products (sugar, molasses, electricity, alcohol, etc.) but at the end of the year it's the bottom line that counts. How much money did the factory make? I learned this the hard way as in my factory in Hawaii, we were able to make the best quality raw sugar in the world. At the budgetary meetings each year, I would propose changes in equipment or process that would make better quality sugar. But the corporate manager would simply ask "Will it make any more sugar?" It is nice to produce exceptionally fine sugar, but if the investment in change does not create increased income, money will not be available for the changes.

- **Sugar is made in the field**

Sugar, (sucrose) is a disaccharide, made up of molecules of fructose and glucose (C_{12} H_{22} O_{11}). Sugar is not produced in the factory but in the field. The factory measures it results in a "Recovery and Loss Report". The factory process cannot make more sugar than what is produced in the field. Furthermore, the factories over the years have increased their efficiencies that increasing recovery is now done in increments of 0.1-1.0%. Because of this, the factories have begun to look at "value added products" to increase their bottom line or increased production to decrease their unit costs.

In the field, however, there is vast potential for gains in sugar yields. Better agricultural practices can increase yields 5-25% with introductions of new varieties. Examples of increased yields ove the past 20 years have led to:

- 2016-17 sugarcane production in Louisiana set a record at 1.78 million tons, resulting from cane yields averaging 7749 pounds of sugar per acre (246 lbs sugar/TC) with 31.5 TC/acre.
- 2017-18 sugarcane production in Louisiana set a record at 1.82 million tons, resulting from field yields averaging 8,853 pounds of sugar per acre.
- Florida field yields reach 40.9 TC/acre.
- In Hawaii, at Ka'u Plantation, cane yield averaged 112 TC/acre on a two-year crop averaging 224 lbs. sugar/TC.

It might be noted that the crops in Louisiana and Hawaii are basically 6-month crops while attaining these yields.

Furthermore, better quality cane equates to increased recover in the factory.

Throughout the sugar industry, one uses tons cane to as a measurement of field yields (tons cane per hectare and tons cane ground per day) and factory production. Perhaps this nomenclature should be changed to reflect the true financial crop, i.e.: tons sugar per hectare and tons sugar produced per day. The factory does not sell cane, bur sells sugar.

- **"It is acceptable to receive cane within a 48 hour window after cutting. Losses will be at a minimum."**

At the ASSCT (AmericanSociety of Sugar Cane Technologists) Meeting this year much discussions revolved around Cane Handling, Field & Transportation Delays and Storage. Below is a test on Dextran in stored cane:

2014 DEXTRAN TEST ON STORED BILLET CANE USING MCA TEST KIT

DATE	10/22/2014			
TIME		9:00am		
SAMPLE SOURCE (STORAGE TIME ,HOURS)		12 HOURS	24 HOURS	48 HOURS
PPM STANDARD		500	500	500
N1 STANDAR(ANTIBODY+STANDARD)		96.00	96.00	96.00
N0 STANDAR(ANTIBODY SOLUTION)		33.20	33.20	33.20
N1-N0 STANDAR		62.80	62.80	62.80
CONTROL FACTOR		7.96	7.961783	7.961783
N1 SAMPLE(ANTIBODY+SAMPLE)		39.7	47.0	102.85
N0 SAMPLE(ANTIBODY SOLUTION)		31.8	30	30.5
N1-N0 STANDAR		7.92	16.95	72.35
BRIX		18	18	18
PPM IN SAMPLE AS READ		63	135	576
PPM DEXTRAN ON BRIX		**350**	**750**	**3200**
CORRECT TO HAZE METHOD	**MAU**	**111**	**375**	**1992**
ACTUAL CORRECT TO HAZE METHOD		111	375	1992

Sugar losses in the field/storage can only be addressed through a properly managed harvesting program which eliminates excess time in the field and transportation delays to the factory.

In Australia, the industry designs their harvesting and transportation program to deliver cane to the mill in less than 16 hours. Australian studies found losses in recovery with whole stalk cane averaged 1.0 – 2.0% per day with losses are greater for billeted cane. Studies also indicate:

Additional losses after 36 hours
- @48 hours (2 days)= 1.0% = $0.80 /TC
- @72 hours (3 days) = 3.0% = $2.40 /TC
- @96 hours (4 days) = 5.0% = $4.00 /TC

Losses for a mill grinding 5,000 TC/d
- @48 hours (2 days)= $2,000 / day
- @72 hours (3 days) = $6,000,000 / day
- @96 hours (4 days) = $10,000 / day

Studies in Louisiana have found:
- Dextran formed in the mill yard averaged 0.3 tons/day or 0.09 lbs./ton cane.
- Daily pol losses in the cane yard averaged 9.8 lbs/ton cane with a high of 26 lbs./ton cane.
- Most of the pol losses in the yard are due to cane washing because tests at many factories in the state have demonstrated average cane washing losses of 6-8 lbs. pol/ton cane.

Louisiana and Florida harvesting and transportation program is designed to deliver cane to the mill within 24 hours.

In Hawaii (Ka'u Plantation), where harvesting is done 24 hours per day, 4 hours of cane was stored in the mill yard after receiving cane ½ - 2 hours transportation from the field. Little work on dextran was made at this time, but in my experience, I found little problem with dextran. But during this time, the low-grade "C" strikes always exhibited elongated grain. We then went over to a harvesting schedule to only have 1 hour of cane storage in the cane yard. Immediately the elongated grain in the low-grade strikes disappeared. This indicates that deterioration of cane begins as soon as it is cut and has immediate effect on recovery.

This is an area which should be addressed to increase quality cane to the mill and increasing recovery. The following areas should be tackled:

- Harvesting Methods
- Direct to Milling
- Storage
- Rotation in Storage (1st in, 1st out)
- Methods of Handling
- Washing
- Biocides

➢ Resistance to Change

In my 39 years assisting the factories throughout the world make equipment or process changes, every factory feels that it is unique unto itself:

- "My factory is different from other factories. How do I know that the proposed change will work?
- "Just because it worked in other factories throughout the world, I need to test it in my factory at no cost."
- "The laws of physics and chemistry are different in my factory from the rest of the world."

It must be understood that the sugar process is a distinct process governed by the same laws of physics and chemistry. If something works at a factory halfway around the world and works at factories in many countries, it will work at every factory. The only caveat is in the resistance to change. Resistance to change is a phenomenon we frequently talk about in project management circles; it's something we often quote as a major reason why projects and change programs don't deliver the results they set out to. At its core, resistance to change is a label we apply to people who seem unwilling to accept a change. But for the most part, it isn't the change itself that people resist. People resist change because they believe they will lose something of value or fear they will not be able to adapt to the new ways.

Tests of new processes or equipment must be addressed differently than proved processes or equipment. John Payne once told me that a manager must be able to asses the probable results and personally accept the responsibility of said tests. But the manager must also understand that is 5 tests are run at a facility, one will be an absolute failure, three will have no effect on production and one will be a success. This is not a great batting average, but all must be tried in order to find success.

Failure is Not the End

Thomas Edison did not like to refer to his inventions as successes or failures. In the field of inventing, it is possible to get bogged down by creations that don't turn out the way you want. However, Edison was not one to focus on what went wrong. He would rather focus on what he could learn or improve.

**Socrates: "The secret of change is to focus all your energy,
but in fighting the old, but in building the new."**

- **"Figures don't lie, but liars figure"
Mark Twain**

Below is a chard depicting dextran tests run in a mill and the extrapolated savings in sugar and value of sugar gained by using dextranase.

SAVINGS DUE APPLICATION OF [redacted](DEXTRANASE)

Mill Capacity, MT 6000

SAMPLE	TREATMENT BEFORE Ave. Dextran ppm/ 100 Bx	TREATMENT AFTER Ave. Dextran ppm/ 100 Bx	% Average Reduction	% CANE	Brix	Sugar Saved, KG	Lkg Sugar Saved	Value of Sugar
Primary Juice	849	831			17.40			
Mixed Juice	1168	928	21	100.00	14.20	1,183.56	23.67	35,507
Clarified Juice	2013	884	56	99.00	15.00	4,023.76	80.48	120,713
Syrup	1788	1204	33	23.00	70.00	2,256.58	45.13	67,697
A-Molasses	3082	1910	38	27.00	84.00	6,379.43	127.59	191,383
B-Molasses	3972	2211	44	12.00	86.40	4,381.93	87.64	131,458
Final Mol	5754	3353	42	4.50	85.00	2,204.12	44.08	66,124
Sugar	411	322	22	10.10	99.60	212.75	4.25	6,382
		Average % Reduction	36				412.84	88,466.22

The numbers indicate reduction of dextran in all sugar processes. This is accurate and the numbers imply that there would be significant advantage to the use of dextranase. The problem with the chart is the savings in sugar and related value of sugar. A factory only sells sugar and molasses, therefore the only gain in sugar or revenue is from these sources. Any sugar saved or values given to Mixed Juice, Clarified Juice, Syrup, A-Molasses, B-Molasses are not viable. The product, Dextranase, is effective and works well so there is no need to enhance the results.

It should have been simplified just to show reduction of dextran throughout the sugar processes as done in a study done in Jamaica:

The findings of the Jamaican SRI (Sugar Research Institute) during the study of the polysaccharide program at Appleton Estates

Products	Dextran Before Trial (ppm/brix)	Dextran During Trial (ppm/brix)	Percentage Change
Core sampler juice	29405	31195	+6.09
Sugar	334	185	-44.61
Crusher Juice	18065	1490	-20.1
Mixed Juice	8996	1171	-86.98
Clarified Juice	23924	3867	-83.84
Filtered Juice	20523	9345	-54.47
Syrup	12134	2636	-78.28
A Massecuite		1724	
A Molasses	5309	2746	-48.28
B Massecuite		20135	
B Molasses	7643	6335	-17.11
C Massecuite		17100	
Final Molasses		3913	
Magma	7554	2085	-72.40

Gains in revenue could be established with sugar sales:

SUGAR QUALITY ASSESSMENT cont'd

Table 8. Projected Penalty or Premiums Applied to Sugar Quality Parameters (US$), Before and During Trial.

Quality Parameters	Before Trial	During Trial	Difference (Pen./Prem.)
Export Weight (Tonnes)	28351	28351	
Polarization	+402162	+515556	+113394
Safety Factor	0	0	0
Affined Colour (IU)	0	0	0
Whole Colour (IU)	0	0	0
Grain Size (28 Mesh)	0	0	0
Dextran (M.A.U.)	-81711	0	+81711
Starch (Ppm)	0	0	0
Ash (%)	-14758	-18343	-3585
Overall			+191520

Note: +ve denotes a premium, -ve denotes a penalty on quality parameter

This simplicity tells a better story than giving economic value to process products which have no monetary value.

- **Molasses Purity is continually used as a measurement of the factory's efficiency**

Very often, managements' superiors use "molasses purity" is singled out as a measurement of successful recovery. Sugar purity is not a true indicator of recovery. A true vale is "pol losses to molasses" as expressed in the Recovery and Loss Report. Below is a chart indicating Cane Sugar Factory Recovery and Losses. Molasses losses goals range from 9.12 to 6.32.

Cane Sugar Factory Recovery (Mill Balance)					
	J.C.P Chen Cane Sugar Handbook	P. Rein Cane Sugar Engineering	South Africa 1988-2005	Florida & Louisiana	John Payne
Boiling House Recovery	89.12	89.4			
Overall Recovery	87.91	86.3	85.86	86.61	84.8
POL Lost % POL in Cane					
Bagasse	1.24	3.5	2.21	4.56	4
Filter Cake	1	0.4	0.23	1.05	1
Molasses	9.12	8.7	9.73	6.32	8.5
Undetermined	0.73	1.1	1.97	1.46	1.7
Total POL Losses	12.09	13.7	14.14	13.39	15.2

As quality if cane increases, purity of strikes rises. The higher the purity of the initial "A" strike, the higher the molasses purity. Below is a Production Report for my mill in Hawaii, where the average syrup purity was in excess of 86 with purities of 90+ during more than half the year. Therefore, strikes were run as "A1" – 92purity, "A2" – 84 purity, "B" – 75 and "C" – 60 purity. Final molasses purity were at 44.3 and 46.3. And yet the loses to final molasses were below the target value of 9.12 set by J.C.P. Chen for the Hawaiian industry. Yet very often I have seen final molasses purities approaching 30, and yet the losses in molasses were at 10%+.

RESUME OF MANUFACTURING RESULTS
Factory: **Ka'u Agribusiness Co., Inc.**

Year	1992	1993
Start of Crop Season	2/21/92	1/20/93
End of Crop Season	12/9/92	11/3/93
Number of Crop Days	201	191
Tons of Cane Milled	415,224	398,889
Tons Milled Per Day	2,065	2,088
Capacity of Mill Per Day	2,880	2,880
Cane —		
% Sucrose	13.21	13.16
% Fibre	15.22	15.08
Bagasse —		
% Sucrose	2.53	2.70
% Fibre	46.6	45.7
% Moisture	50.8	51.5
Crusher Juice —		
% Brix	16.51	16.48
% Sucrose	14.61	14.57
% Purity	88.55	88.40
Normal Juice —		
% Brix	11.75	11.36
% Sucrose	10.21	9.85
% Purity	86.88	86.72
Syrup — % Purity	86.01	85.14
Normal Juice — Extraction	—	—
Suc. Extraction — % Suc. in Cane	92.8	92.2
Maceration — % Cane	40.4	45.0
Recovery — % Sucrose in Juice	80.7	81.6
Yield — 96° Test — % Cane	7.87	7.91
Tons 96° Test Sugar	47,285	45,677
Polarization	99.37	99.35
Mud % Pol.	4.56	4.57
Final Molasses —		
Brix	85.02	85.04
Sucrose	37.9	36.0
Purity	46.3	44.3
Gallons Per Ton of Cane	6.03	5.53
Lime Lbs. Per Ton of Cane	1.66	1.11
Gas MCF Per Ton of Cane	—	—
Sucrose Account —		
% Cane —		
In Bagasse	7.15	7.73
In Final Molasses	9.41	7.85
In Mud	1.90	1.53
Undetermined	0.74	1.24
Total Losses	19.20	18.34
In Sugar of 96° Test	80.80	81.66
Grand Total	100.0	100.0

As mentioned above, the higher the purity the higher the crystal content of the massecuites and therefore the more commercial sugar can be recovered with each strike. Example #1, calculates the crystal content and the recoverable sugar (based on the use of the Hawaiian Equation for Crystal Content and SJM Formula for 100 tons available sugar) at a high purity of 86%. The calculation shows a crystal content of 50.13% in the "A" strike with a recovery of 50.13 TS. Overall, 83.04 sugar would be recovered.

Example #1

Strike	Crystal Content in Massicuite		Hawaiian Equation % Crystal Content	SJM Formula	T/S
A	Massicuite Purity	86.00	50.13	62.02	50.13
	Molasses Purity	70.00			
	Massicuite Brix	94.00			
B	Massicuite Purity	75.00	42.22	59.26	21.05
	Molasses Purity	55.00			
	Massicuite Brix	95.00			
C	Massicuite Purity	60.00	41.14	71.43	11.85
	Molasses Purity	30.00			
	Massicuite Brix	96.00			
				Total Recovery	**83.04**

Hawaiian Equation

$$\%\text{ crystal in massecuite} = \frac{\text{massecuites purity} - \text{molasses purity}}{100 - \text{molasses purity}} \times \text{massecuites brix}$$

SJM Formula

$$\frac{\text{Parts crystal in sugar recovered}}{\text{per 100 parts sucrose in massecuite}} = \frac{100^2}{\text{massecuite purity}} \times \frac{\text{massecuite purity} - \text{molasses purity}}{100 - \text{molasses purity}}$$

Example #2 has a "A" strike purity of 82% which drops the crystal content 41.13% and a sugar recovery of 41.13 TS. Overall, there is a decrease in recoverable sugar of 3.06 TS. It is therefore good factory practice to run strikes at the highest purity possible (i.e.; straight syrup stirkes).

Example #2

Strike	Crystal Content in Massicuite		Hawaiian Equation % Crystal Content	SJM Formula	T/S
A	Massicuite Purity	82.00	41.13	53.35	41.13
	Molasses Purity	68.00			
	Massicuite Brix	94.00			
B	Massicuite Purity	75.00	42.22	59.26	24.86
	Molasses Purity	55.00			
	Massicuite Brix	95.00			
C	Massicuite Purity	60.00	41.14	71.43	14.00
	Molasses Purity	30.00			
	Massicuite Brix	96.00			
				Total Recovery	**79.98**

Hawaiian Equation

$$\% \text{ crystal in massecuite} = \frac{\text{massecuites purity} - \text{molasses purity}}{100 - \text{molasses purity}} \times \text{massecuites brix}$$

SJM Formula

$$\text{Parts crystal in sugar recovered per 100 parts sucrose in massecuite} = \frac{100^2}{\text{massecuite purity}} \times \frac{\text{massecuite purity} - \text{molasses purity}}{100 - \text{molasses purity}}$$

➢ "Back-Boiling or Topping Off Strikes Reduces Final Molasses Purity"

Example #3 demonstrates what happens when "A" molasses is used to "Back-boil or Top-off" a "A" strike. This method of boiling is used to lubricate the massecuites prior to being dropped into the centrifuges.

1. Since the strikes are dropped at high brix, throughput in the centrifuges is retarded. Today, this is no longer necessary since surfactants are now available to reduce the viscosities.
2. By lowering the purity of the initial strike, final molasses purities will be lower, bur losses to final molasses will increase. Furthermore, the "A" molasses, used to "Back-boil or Top-off" the strike, has been exhausted of sugar. By returning the exhausted molasses, the factory wastes energy in boiling materials that result in no increase in sugar recovery. Additionally there is a reduction in sugar recovery of 4.41 TS.

Example #3

Strike	Crystal Content in Massicuite		Hawaiian Equation % Crystal Content	SJM Formula	T/S
A	Massicuite Purity	80.00	35.25	46.88	35.25
	Molasses Purity	68.00			
	Massicuite Brix	94.00			
B	Massicuite Purity	72.00	35.89	52.47	23.24
	Molasses Purity	55.00			
	Massicuite Brix	95.00			
C	Massicuite Purity	60.00	41.14	71.43	17.08
	Molasses Purity	30.00			
	Massicuite Brix	96.00			
				Total Recovery	75.57

Hawaiian Equation

$$\%\ \text{crystal in massecuite} = \frac{\text{massecuites purity} - \text{molasses purity}}{100 - \text{molasses purity}} \times \text{massecuites brix}$$

SJM Formula

$$\frac{\text{Parts crystal in sugar recovered}}{\text{per 100 parts sucrose in massecuite}} = \frac{100^2}{\text{massecuite purity}} \times \frac{\text{massecuite purity} - \text{molasses purity}}{100 - \text{molasses purity}}$$

➢ "All Chemicals Are the Same"

Chemical products, even though labeled the same, may not be equivalent in chemical makeup or activity. Several years ago, a supplier sold Amylase as Dextranase due to the price advantage (Amylase being 1/3 the price as Dextranase). Was it legal? Technically yes since Dextran has α 1-4 linkage and therefore the Amylase will cleave those linkages. But Dextran is considered a molecule of α 1-6 linkages.

If a price seems too good, it probably is not the same product.

The supplier should have a Research and Development. Does the supplier know what, where and how to use the product?

There should be a training program for the economic use of the chemical.

A service program should be established covering the installation of and monitoring of the product.

Follow-up not only on the use but on the results.

- **The company is buying results, not chemicals**.
- **Is there an economic payback?**

➢ "Who's the Boss?"

Partnership with "Service Providers"

When working with a "Service Provider or Supplier", be sure to arrange a partnership with the factory supervisory group being the party in charge. All reports, irregularities and results being reported in a timely manner. Since all processes within the factory are interrelated, it is important to have a stream of knowledge flow between factory and service provider. Communication is the key to success.

Program

1. Research and Development – Does the supplier know what, where and how to use the product.
2. Training program for the economic use of the product. The training program should be directed to insure the operators know more about the product or process than the provider by the end of grinding.
3. Service
    1. Installation
    2. Monitoring
4. Follow-up not only on the use but on the results.
    1. **The company is buying results, not chemicals**.
    2. **Is there an economic payback?**

Partnership Failure (An example)

Tube failures in Boiler on start-up

- Highly scaled tubes (Calcium hardness deposits)
- Cause: Factory personnel failure to monitor and repair water softener pretreatment
    - Many hardness readings in excess of 60-96 ppm
    - Do not regenerate demin units until hardness is indicated
        - 'Zero' hardness parameter not understood
    - Analyses are not done every 2 hours but 4 hours after a regeneration
    - Feed water hardness showed readings in excess of 10 ppm almost every day
        - This year, hardness readings have been reading between 0 – 0.5 ppm.
    - Acid for regeneration of the cationic resin couldn't be supplied (purchasing difficulties)

Expert assistance or lack thereof:

- Boiler treatment professional
    - Only visited the demin water plant once to drop off report, but made no comments toward correction of problems
    - High hardness readings noted on daily reports
    - No effort made to change program to a hard water program
    - Monitors feed water but does not attempt to rectify any problems
    - No training
    - No explanations of program
    - Does resin analyses but have not delivered reports
    - Borescope done, but no report delivered.

- **"I cannot make the final decision."**

The manager has the primary responsibility to make decisions covering all areas of production and process. His job hangs on the success or failure of these decisions. Should the manager leave such responsibility to another party who may have never worked in a sugar plant?

The managers second important duty is to change that decision should the need arise. Do not attempt to save face. Make the change.