Strategic Cost Management in Black Tea Processing

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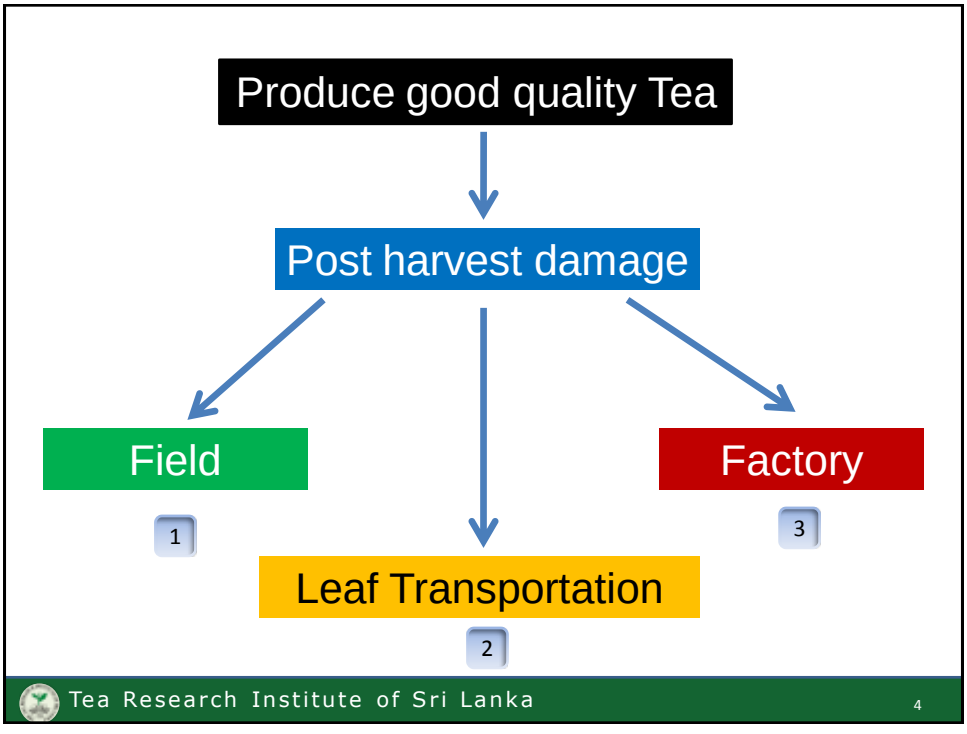
Background

- Quality – consumer demand driven
- Good Quality Tea – better price
- To Produce GQT – required better quality tea shoots
- To receive better quality shoots – harvest shoots with good leaf standard & minimize post harvest losses
- Managing the cost of processing

Classification of Leaf Standard (Weight basis)

- Best leaf
  - Bud & a leaf
  - Bud & two leaves
  - Bud & three leaves (tender third leaf)
  - Tender banji shoots
  - Arimbu
- Below best leaf
  - Tender damaged shoots or leaves
- Coarse leaf
  - Mature single leaves
  - Mature banji shoots



Plucker	No. of shoots in hand	Damaged leaf %
1	115	18.8
2	118	22.2
3	120	18.0
4	121	22.2
5	131	21.9
Average	**121**	**20.6**

- Post harvest losses at the plucking stage

TRI recommended light weight plucking basket

New basket against Conventional plucking

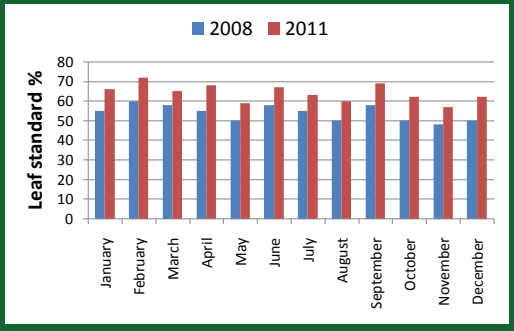
Replicate	Leaf %	Day 1	Day 2	Day 3	Day 4
CP	Damaged	26.5	23.5	29.2	24.6
PB		14.2	10.9	12.9	6.8
CP	Coarse	21.7	38.5	35.5	37.0
PB		13.3	36.5	38.2	37.9

Parameter	Tasters score	
	CP	PB
Infused leaf	4.0	5.0
Liquor color	5.0	4.0
Strength	4.5	4.5
Quality	4.0	5.0

Parameter	Chemical Quality	
	CP	PB
TF %	0.99	1.04
TR %	14.71	15.38
TC %	4.07	4.26
BR %	26.27	26.28

CP – conventional plucking system
PB – plucking with TRI plucking basket

Improving leaf standard & reducing damaged leaf % in one factory



- A factory – improved the average standard of leaf from 54 to 64

Month	Damaged leaf (%)	
	2008	2011
January	18	7
February	20	9
March	21	6
April	25	5
May	28	6
June	23	8
July	25	7
August	30	6
September	23	9
October	31	5
November	20	6
December	29	8

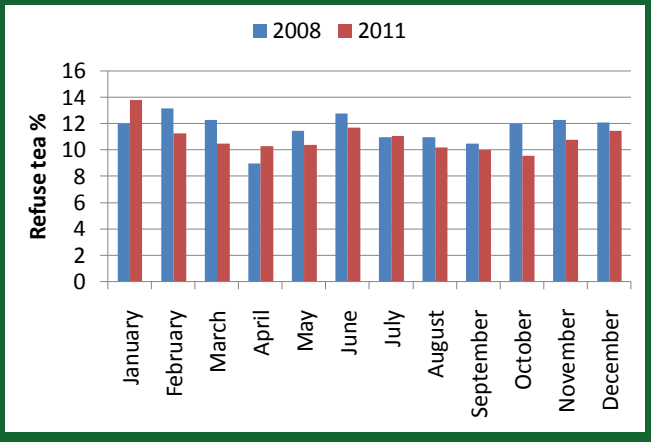
- Minimizing the damaged leaves, a significant impact can be done to NSA
- Their rank was increased from 84 to 35.

Factory rank	Annual to date NSA (Rs)
35	325.60
36	324.40
37	321.12
38	319.49

- Implementation of strategies to reduce losses during plucking and weighing

1. Maintained correct plucking rounds – incentive scheme was introduced to field staff & plucking Kanganies
2. Picked and removed coarse leaf during cropping season
3. Training programs were organized for workers, field & factory staff

Refuse tea % has reduced in 2011 compared to 2008



Reduction of average RT= 3.5%

Contaminations

- Poor handling like use of fertilizer bag for packing & weighing
- Placing the weighed leaf carelessly under unhygienic conditions

Tea with sand particles

Transportation

Quality of tea leaves losses due to

- Poor transportations
- Distance transportations
- Delay in transportations
- Bad roads

Transportation

- Tested three types of leaf packing materials in low country region for distance transportation

Crate

Coir bag

New bag

- Packed 16 & 20kg leaves in each container and transported about 20 – 25 km
- Leaf damaged % of each container was evaluated.

Transportation

Damaged % of plucked tea leaves

Quantity packed	Crates	Coir Bags	New Bags
16 kg	16.5	23.4	20.6
20 kg	27.5	28.7	21.1

- Comparing three types packing materials crates showed better results for 16kg. However, when the quantity increases to 20 kg crates are not suitable for distance transportation.
- New bag – no variation for both quantities, due to large bag size.

Transportation

Leaf Standard %						
	Good		Damaged		Bad	
	Crate	Bag	Crate	Bag	Crate	Bag
Before	55.5	53.4	26.2	24.5	18.3	20.2
After	54.2	51.9	27.8	29.2	18.1	20.9

Factory operations

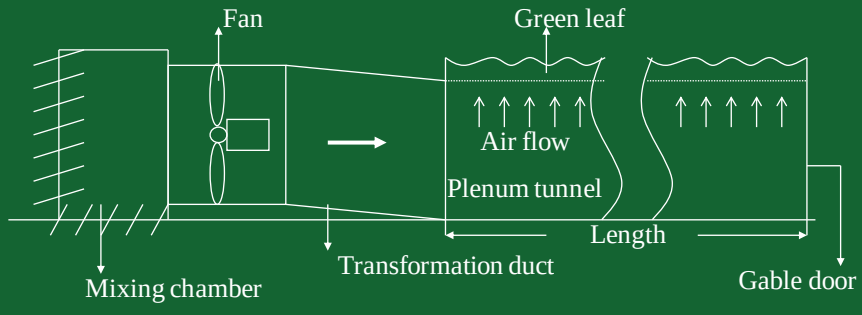
Possible post harvest losses and saving opportunities in cost of processing

- Weighing
- Withering
- Rolling
- Drying

- Weighing at the factory premises

Very poor handling of plucked good shoots/leaves

Withering process



- Objectives – optimize withering parameters
  efficient use of hot air
- Several trials – carried out

Withering process – what we did

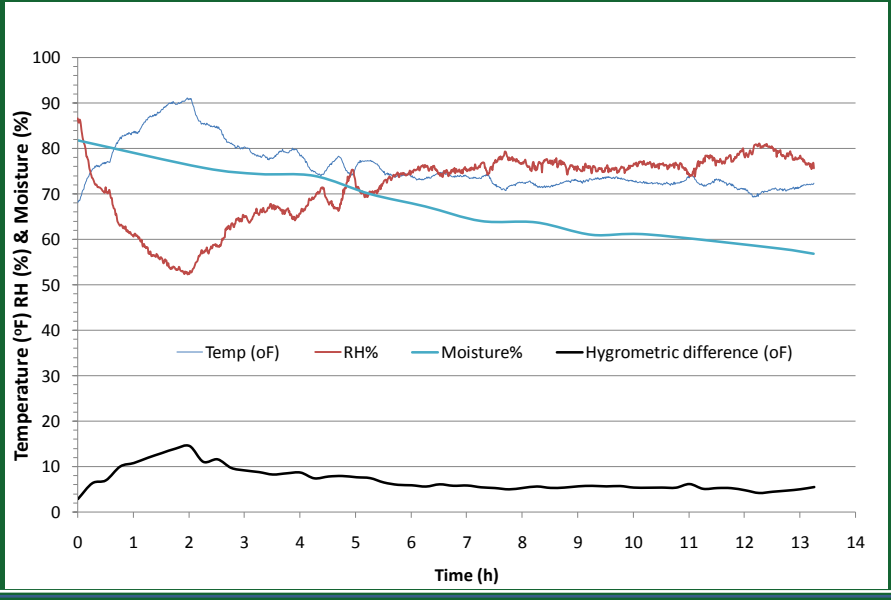
- Load a trough – 2.5 kg/sq.ft
- Airflow was controlled – 24, 20, 16 cfm/kg GL
- Temperature and RH of hot air supply were controlled & monitored at real time

  Wet leaves ➡ 8 - 10^{o}F

  Dry leaves ➡ 4 - 6^{o}F

- Leaf samples – every hour collected for moisture determination
- Withering fan – Power consumption was measured

Withering process - results



Withering process - results

Study hygrometric difference and Specific power consumption during withering at different airflow rate

Airflow Rate (cfm/kg)	Moisture %		Hygrometric Difference (°F)		Withering period (h)	Specific power Consumption (kWh/kg MT)	Observations
	Initial	Final	Until S/M removed	After S/M removed			
24	76.3 (D)	56.0	-	4 - 6	13.0	0.23	Good
24	81.1 (W)	56.9	8 - 10	4 - 6	14.5	0.25	Good
20	77.4 (D)	58.0	-	4 - 6	13.5	0.17	Good
20	80.0 (W)	57.0	8 - 10	4 - 6	15.5	0.19	Good
16	77.0 (D)	56.0	-	6 - 8	16.0	0.06	Uneven
16	79.4 (W)	59.1	8 - 10	6 - 8	18.0	0.09	Very uneven

Spreading rate - 2.5 kg sq.ft

About 23% energy can be saved

Withering process - recommendations

- **Monitor efficient use of hot air for withering using hygrometer**
  - **for wet leaves : 8 – 10°F (until surface moisture is removed)**
  - **for dry leaves : 4 - 6°F**
  - **(maintain dry bulb T ≤ 90°F)**
- **Recommended flow rate of air: 20 cfm /kg GL**

Leaf discoloration

No discoloration

Withering process - achievements

Power saving in withering by adjusting pitch angle of withering fans which deliver large airflow

Details of trough		Required Airflow (cfm) @ 3kg/ft²	Before Adjustment		After Adjustment	
Length (ft)	Motor HP		Airflow (cfm)	Power (kW)	Airflow (cfm)	Power (kW)
75	10	27,000	36,600	5.9	31,800	5.2
75	10	27,000	36,400	6.3	31,900	4.0
75	10	27,000	41,900	5.7	35,400	4.3
75	10	27,000	41,200	7.2	35,500	4.9
80	10	28,800	40,900	6.8	35,000	4.4
80	10	28,800	36,200	3.9	33,000	3.1

Power saving was about 12 – 32%

Withering process – achievements …

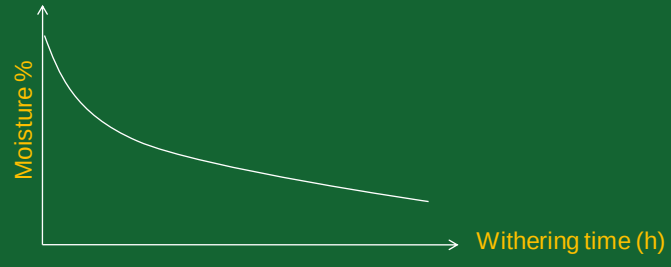
- **Potential of reducing the withering cost**

Power saving from six troughs = 10 kW
Units saved by running 12 h /day = 120 units
Units saved by running 12 h /yr = 36,000 units
(assumed no of days work – 300)

Annual saving = Rs 0.44 million

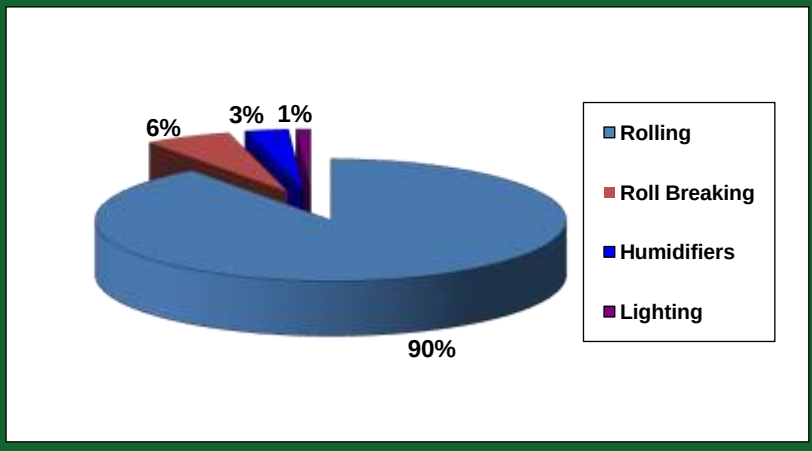
- If a trough consisted with VSD, without varying pitch angle airflow can be further reduced to the required levels.
- Closing airflow damper will not help to reduce power consumption.

When using VSD

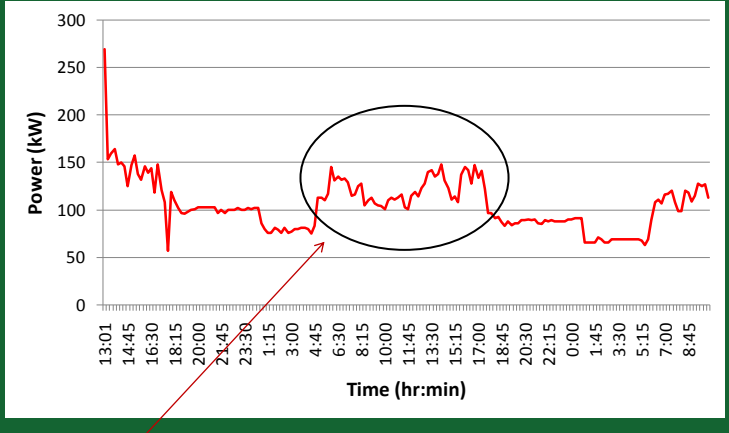


- **Initial stage of withering, Fans run at full speed. Therefore no energy saving by VSD.**
- **Just after turning, VSD can operate to reduce the frequency up to 1/3. That saves energy.**
- **Expected saving – 40% from total power for withering**
- **Annual power saving – 63,360 units @ 0.44 kWh/kg MT**
- **Annual cost saving – 0.8 million**

Rolling Room- Energy Balance



Rolling Process...



Shifting at least 50% total rolling period into off peak period, about 15% from total cost of rolling can be saved.

Drying Process

- Correct setting of Drier inlet and outlet temperatures – very important to produce quality made tea
  - Thermometers calibration
  - Certain factories in low grown processing use 240^{o}F as Inlet Temperature
  - If the Inlet temperature bring down to 220^{o}F – 10 % saving of firewood

Saving = 1cu.m / 8hrs

Firewood Feeding - Furnace

- **Start the ID fan ON and ignite the firewood and keep on feeding firewood to heat up the furnace**
- **After about 25 minutes switching on main fan, keep the main fan damper at ¼ open.**
- **Once the required temperature is achieved, open the damper to required position.**
- **Start feeding firewood to the furnace at a constant rate (about 50 kg) at every 10 - 15 minutes interval.**
- **Time interval depends on the drier output.**

Specific fuel wood consumption

Three tests were conducted to determine specific fuel wood consumption of a furnace in a factory.

Test 01	-	Normal factory operation
Test 02	-	Fed 50 kg of 1 m length firewood in constant time intervals
Test 03	-	Fed 50 kg of 0.5 m length firewood in constant time intervals

Test	Specific energy consumption kg of FW / kg of made tea
01	1.10
02	0.82
03	0.79

Above experiment 25% firewood save - Test 02
28% firewood save - Test 03.

Split raw firewood – better way of stacking

– Moisture content was reduced from 48% to 25% within 5 weeks

Firewood Splitter

- **A trial carried out during operation of splitter – changing power consumption when splitting raw and dry firewood** (several common species used)

Power consumption kWh /cu.m.		
	Dry logs	Raw/wet logs
	5.6	3.25
Moisture (%)	25	48

- **Power Saving 2.35 kWh/cu.m.**
- **Annual saving is 3625 units.**

Deenside Splitter

I D Fan Damper position

- Close damper to a lower position
- Observe the colour of smoke passing through chimney
- Adjust ID fan damper position until passing white smoke from chimney

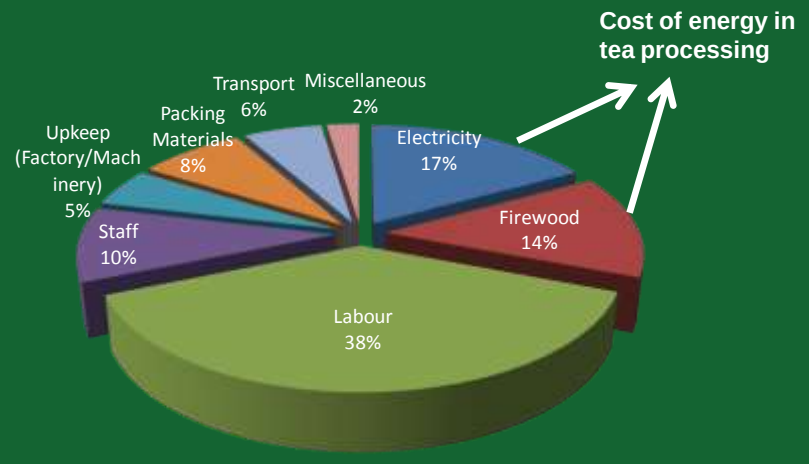
Fuel saving 150 cu. m. / year

ID Fan - ducting modification

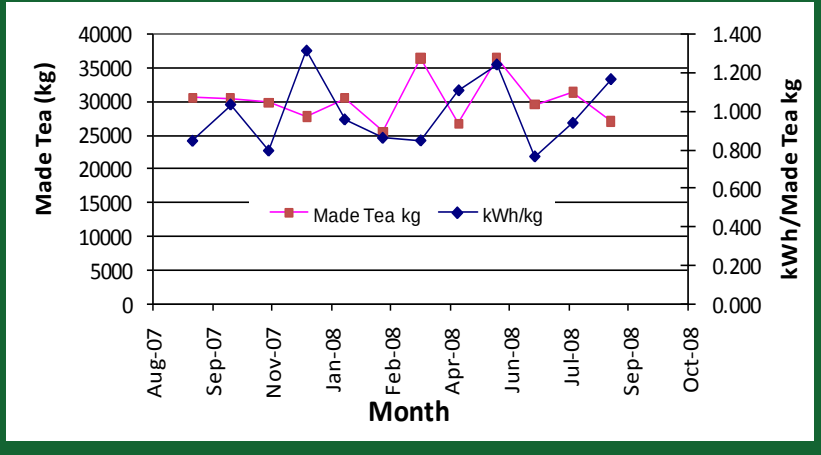
- When two driers are having common ID ducting, both ID fans are required to operate even if one dryer is working.
- By modifying to operate one ID fan;

Annual Saving 8275 kWh

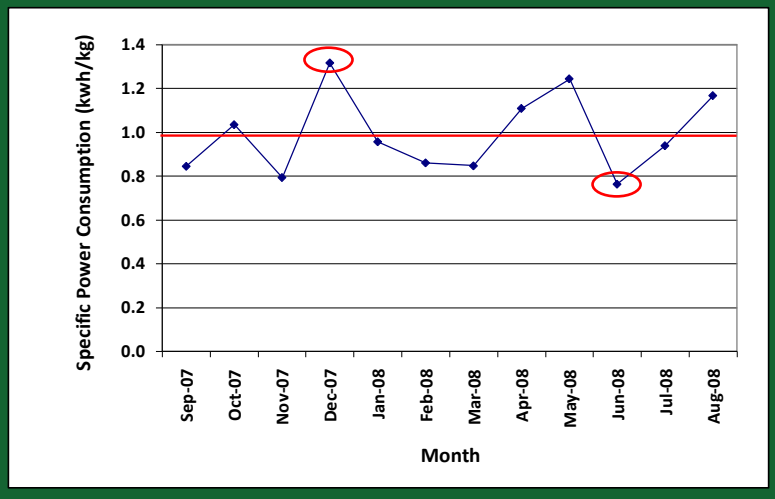
Energy Audit – carried out in a tea factory



Specific electricity consumption



Specific Electricity (Power) Consumption Vs Quantity of Made Tea



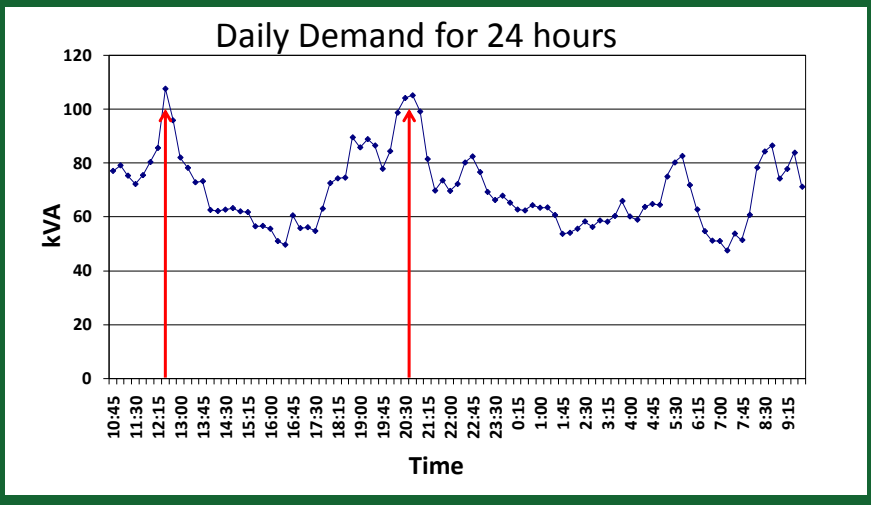
Average Specific Power Consumption = 0.99 kWh/kg MT

- **Average Specific Power Consumption(SPC) – 0.99 kWh/kg MT**

Maximum SPC – 1.38 kWh/kg MT
Minimum SPC – 0.76 kWh/kg MT

- If the average power consumption reduced 0.99 to 0.76 kWh / kg MT
- Annual power saving = 0.23 kWh x MT kg x 12
- If made tea quantity = 30,000 kg/month
- Annual Power Saving = 82,800 units(kWh)

- **Annual Saving = one million**



Peak demands – 1. 12.15 pm – 1.00 pm
2. 8 pm – 9.15 pm

- Keep the kVA demand to the minimum
  - Use of capacitor banks
- Managing the major loads during peak hrs
- Avoid use of motors rewound many times (excessive no load loss ~ 40%)

Lighting

- **Replace 5 ft bulbs with 4 ft bulbs** (hanging height should be adjusted)

Saving	**-**	**0.36 kWh/bulb/day**
No of Lamps	**-**	**17**

Annual Saving 2200 kWh

Summary

1. Post harvest losses at the plucking stage can be minimized by using TRI recommended plucking basket.
2. For distance transportation of leaves, crates filled with 16 kg are more suitable to reduce the post harvest losses.
3. Minimizing damaged leaves % has positive impact to quality and price improvement.
4. Weighing points at the factory premises should be given special attention to minimize damaging the leaves.
5. To minimize discoloration of withered leaves it is recommended to use 8 - 10^{o}F for wet leaves and 4 - 6^{o}F for dry leaves.

Summary (contd.)

6. Excessive air for withering results wasting electrical energy. About 23% energy can be saved by reducing airflow to 20 cfm/kg GL.
7. There is a big saving potential from withering cost by fixing VSDs' for withering fans.
8. Advancing the rolling process into off peak periods, there is a saving potential of electricity cost for rolling.
9. Correct setting of inlet temperature and feeding of firewood at the rate 50kg for 10 – 15 intervals save firewood used in withering & drying stages.

Summary (contd.)

10. Splitting firewood under raw condition saves power and can reduce moisture within very shorter period.
11. Adjusting ID fan damper in a correct manner to correct position & setting independent paths for ID fans in case of two dryers are used, it helps to save power considerably.
12. Factory is running above 50% of the factory capacity specific electrical and fuel energy consumptions are reduced.
13. Improving Lighting system may also reduce power consumption considerably.

Thank You For Attention !

- **Correct airflow adjustment of withering**
- **Advancing rolling process into off peak periods**
- **Organizing to split firewood in raw condition**
- **Modifications of ID fan ducting arrangement**