ILAM TEA: PEAK SEASON CAPACITY CONFORMANCE PRACTICE IN PROCESSING ORTHODOX TEA

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ABSTRACT

This study carried out in a pioneer tea factory of Nepal highlights a case of capacity conformance practice in orthodox tea manufacturing system. Analysis of manufacturing data collected through inplant observation of 47 rolling lots proceeds to explore the relation between load administration practice and designer's machine capacity specification through hypothesis testing. When viewed in aggregate, it is concluded that prescribed capacity does not conform in the peak season, and incongruent prescribed and applied load of rolling machines in this manufacturing unit is largely a problem related to job behavior. At the end, keeping *Kaizen*-mind, practical tips have been suggested to show how this manufactory can iNsure a permanent load conformity position of the rolling operations that finally help in achieving the Total Quality Management (TQM).

INTRODUCTION

Tea plantation in Nèpal was first started by the individual initiation of Col. Ganja Raj Thapa, the son-in-law of Prime Minister Junga Bahadur Rana, in 1863 AD. Nine decades later, the Nepal Tea Development Corporation (NTDC) was established (Sharma, 1995: 3). Ilam Tea Estate is the first commercial tea-processing unit which have more than 80% *Sinensis* tea plants (a high quality small-leafed Chinese tea_ cultivated in its garden. Later, the development of tea estate gradually spread from east to west part of Nepal.

In the year 1985, the region comprising of Dhankuta, Terhathum, Panchthar, Ilam and Jhapa was declared as 'Tea Zone'. This declaration brought about an effective change in the tea industry in the country. Various incentives were given to the development of the tea sector. For example, nominal land tax was improved and a subsidy of 50% over interest was given for periods of 5 and 7 years in the Terai and hills respectively. These facilities were terminated in FY 1989/90 resulting in the closure of nearly 40 private companies. The reason given for the same was improper utilization of land and the credit facilities.

Lately, a number of new tea estates in eastern Nepal have adopted organic garden to exploit the new opportunity accorded by the changes in consumers' taste and demands for chemical free foods in the international markets. Some of the tea estates in this field are Kanchanjungha Tea Estate of Panchthar, Deurali Tea Estate of Sangrumba (Ilam district), etc. Unlike the CTC tea, orthodox tea contains a relatively high amount of flavor and a mild color.

Nepal has been exporting tea mainly to Germany and Japan, and it is reported that Nepalese tea is gaining popularity in those countries. It is now estimated that Nepal has been meeting about 60% of her domestic demands for CTC tea through imports. Basically, Nepal has a good market for CTC tea, whereas, there is no option but to export orthodox tea manufactured in the hills. In the FY 1998/99, Nepal earned about 1.09 million US Dolars (US$ 1 = NRs. 68.65) from the export of tea. It is estimated that out of a total 3,000 h. tea planted area, NTDC, private tea estates and small-holdings occupy 31, 54 and 15 percents respectively, and employing a total of 6,000 manpower.

The recent trend in the international markets show that consumers' detachment from chemical food and beverages has created a wide market access for organic orthodox tea. At the same time, the reported malpractice to hallmark lowland-tea as highland one has resulted in the sudden drop in the demand for Darjeeling tea which had so far been enjoying full advantages in the past. Nepal's topography and climate is suitable for producing quality tea and coffee. Thus, with a bit of market sensitivity toward preferred standard, there is an opportunity to provide an alternative to Darjeeling tea in Nepal.

A decision had been made regarding the lease of NTDC to the Sanghai Group, a well-known business house in Nepal, for 50 years. After shaking hands with the private sector, the government will maintain a stake of 35% equity in this corporation. In addition, a ministerial cabinet decision has recently been made to privatize NTDC during the Ninth Five-year Plan. These conflicting decisions made by two governments within just two and half months may create problems in the privatization process.

SCOPE OF THE STUDY

This study is conducted before impending scuttlebutt of privatization of this factory. It may serve as a source of reference for subsequent studies as there is no system of maintaining permanent records on the administered loads of rolling machine in this factory. The capacity conformance status of this factory after its privatization can be compared with the present one. Lastly, the researcher spent more than five years studying various aspects of the production system of this unit. Therefore, recommendations have been derived by integrating other studies as well. This study benefits in expanding the span of knowledge on operations management which can be used for academic purpose, and is also useful for improving the conformity position in the factory to lead the factory toward the concept of Total Quality Management (TQM).

Unlike economists, the third wave management considers information a vital factor of production (Gibson, R. 1997: 10). Nepalese tea industry is characterized by lack of production related information. This factor is found to be less emphasized in many manufacturing industries due to slow development of industrial consciousness. Unlike in many other developed and developing countries of the world where research work goes side by side with the development of industry, Nepal's case is quite different. Tea manufactories in many countries have been incorporating unrelenting researches and studies and these have led to improvised operations process and technology. Improved in-plant processes helped boost their product quality and market access potential. This has resulted in significant contribution to their national economy. Manufacturing system together with research has now assumed integral roles in many industries including tea. Separate research bodies have been formed to disseminate new information in some SAARC countries as well.

OBJECTIVES

The objective of this study is to see, by hypothesis testing, whether capacity conformance in the rolling process of the tea factory is practiced in the peak season. The secondary objective is to calculate clear conformity rate and basket conformity rate with the observed load performance data of rolling operations.

METHODOLOGY

The procedure for data collection for this research is in-plant load observation of 47 rolling lots in Ilam Tea Estate and their immediate recording. Studies on tea plucking character of *Sinensis* and *Assamica* breeds, temperature conformance in weathering truss, inter-process shrinkage character of input, status of standard and actual task of this factory had been completed prior to undertaking the present study. Prior studies have helped determine the peak time of this factory in the rolling process.

This study is conducted for a period in the month of July 1997 by observing more than one roll a day. The month of July is selected for being the peak season for processing tea. The extent of tea plucking is highest during this month. Beside this, some primary data from previous studies have been used to see other aspects of tea industry. Observed data of load in rolling machine has been tested using the Z-test tool. Individual rolls are later checked against acceptance and rejection limits and then listed. This is the basis for computing the basket conformity rate. For a more reliable interpretation of the significance of data, a test of goodness of fit (Chi square test) is carried out using SPSS statistical computer software.

LIMITATIONS

The present study considers July as the peak seasons. The quantity of green-leaves collection is the highest in this month with similar trend during the preceding years.. However, variables such as the rate of monthly precipitation, aging-mix character of the garden, activity of cropping insect, etc. may affect the credibility in the assumption of peak season. In this context, July may not be the real peak season every year. Although the sample size in enough to apply normal distribution, data are based on rolling carried out in the month of July. Thus, the result of this study reflects on rolling operation practice of this unit in the peak season. One can not construe it as reflecting a total conformity position. There

are many other factors of capacity conformance in tea processing, and rolling is just one part.

STATEMENT OF THE PROBLEM

In 1996, this factory remained out of operation for the whole season due to a massive maintenance program of its plants and machinery. This was an abnormal repair program in the history of this factory. As a result, green leaves extracted from the garden were sold to a private tea processing company (Small Tea Producers Pvt. Ltd. of Fikkal). The researcher hypothesized that plants and machinery have not been operating within the capacity limits designed and prescribed by its manufacturer. Mismatching of loads in the workshop performance could be one of the major reasons for warranting such monster-repairs forcing the stoppage of a year's production. As a matter of fact, this is the main statement of the problem and the backdrop leading to the commissioning of this research study in 1997.

HYPOTHESIS

The following are null hypothesis and alternative hypothesis of this research study:

Null Hypothesis (H_0): There is no significant difference between the prescribed capacity (by the machine manufacturer) and the mean of concurrent capacity utilization of the rolling machines (H_0: the mean load practiced in rolling machine is = 80 Kg).

Alternative Hypothesis (H_1): There is significant difference between the prescribed capacity (by the machine manufacturer) and the mean of concurrent capacity utilization of the rolling machines (H_1: the mean load practiced in rolling machine is > 80 Kg) (i.e. right-tailed hypothesis)

PRESENTATION AND ANALYSIS OF DATA

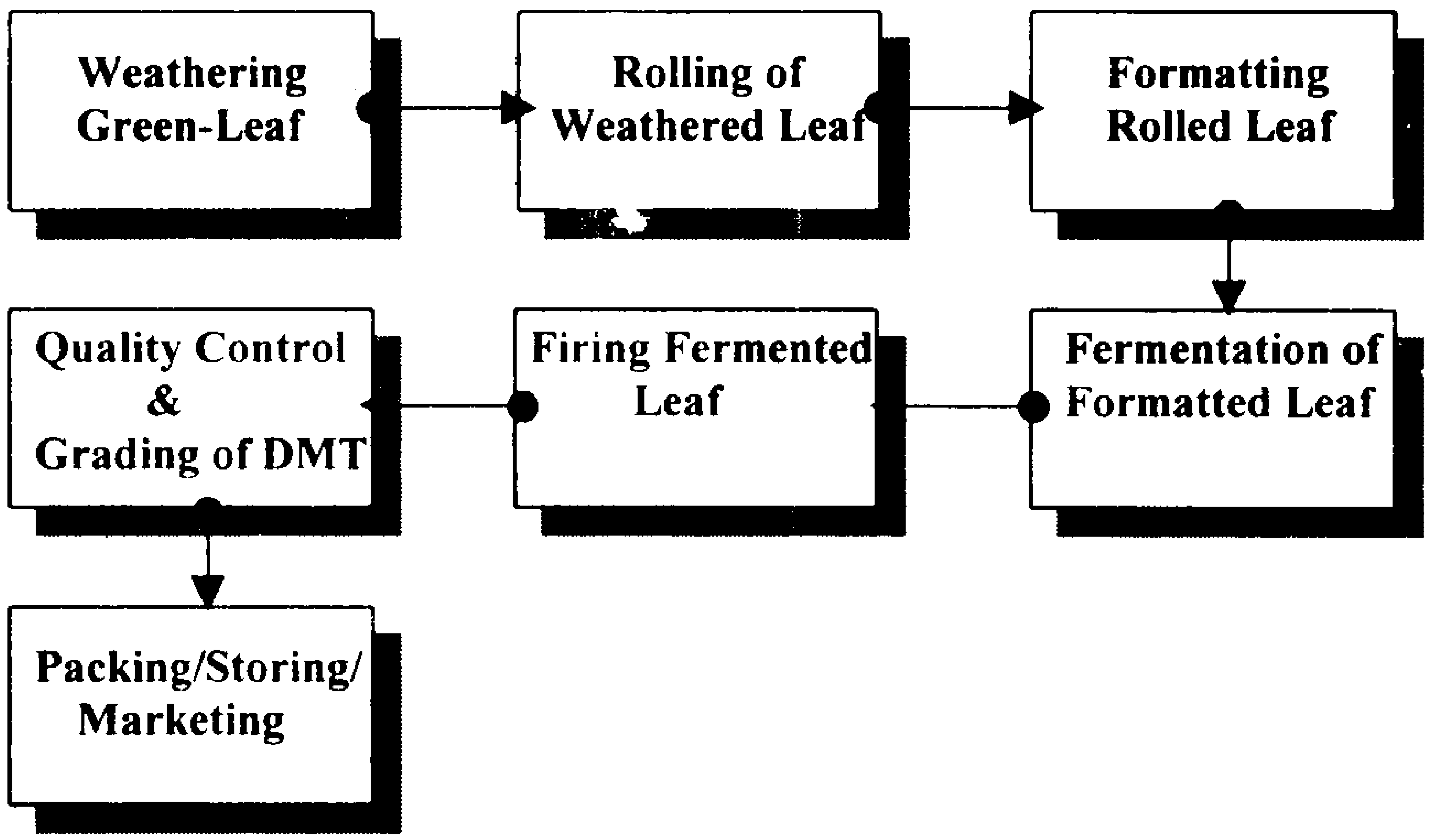
ORTHODOX TEA PROCESS

Green leaves lose about 68. percent of its original weight before reaching the rolling process, and coarse tea (DMT) recovery is between 20 to 27 percent of the weight of green leaves. Tea is sorted to eleven varieties and the best quality is known as *SFTGFOP* that comes from the top burgeon of any plucking (Please refer to Annex for grading system). 100 Kg. of DMT (coarse tea before grading) from March-April plucking produce about 7 Kg. of *SFTGFOP*. "*Ilam Tea*" is the commercial brand of NTDC and the best quality orthodox tea, and is packaged in tin-containers to be sold in both the domestic and the international markets.

The basic condition of orthodox tea is to maintain, beside other criteria, the temperature balance during weathering and fermentation stages.

Biochemical studies on fermentation of tea indicate that the activity of enzyme is dependent on temperature and it is most active between 80^{0}F and 90^{0}F. At lower temperature, its action is very slow. The temperatures administered in weathering tealeaves in this factory are perfect (Please refer to Annex - 1). The enzyme in tealeaves is natural ferments that contains acid and oxidizable substance like *Chetchins*. Enzyme is rapidly destroyed at high temperature and its survival is limited as any temperature above 120^{0}F (Keegel, E.L., 1983: 10). In Nepal, three types of orthodox tea are manufactured, viz., black, green and handmade. The handmade tea is widely manufactured in small scale by farmers and those estates that do not have tea-processing plants. Black orthodox and green orthodox tea need slight modification the manufacturing process of factory. After plucking fresh tea leaves from the garden, the processing of orthodox tea in a factory undergoes the following seven steps. This is shown in Figure - 1:

Figure - 1: The Seven-Processes of Orthodox Tea Manufacturing

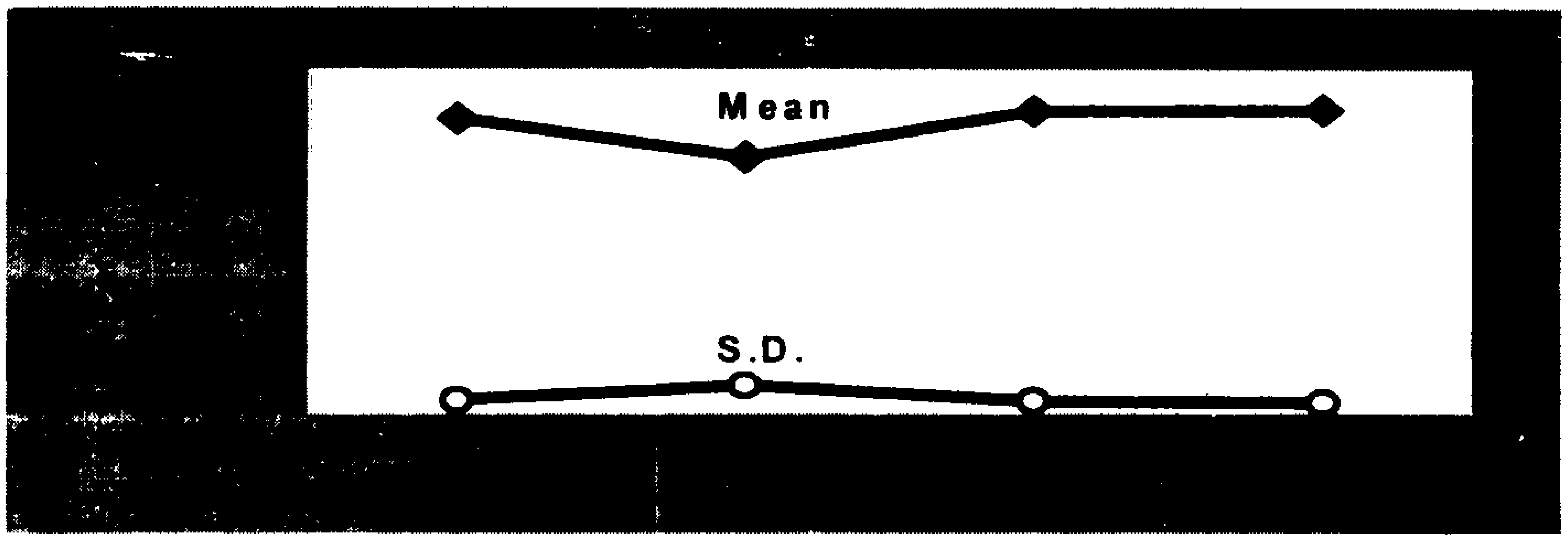


ROLLING OPERATION AT A GLANCE

Only 32 percent of the original weight of the green-Leaves reach to rolling process. The monthly shrinking character of green-leaves during weathering process is evident by the reduced quantity of leaves that actually reach the following machine as shown in Figure - 2. Data obtained from observations in the factory indicates that a total of 4,278 Kg. withered leaves are rolled in 47 rolling operation. During peak tea plucking season, a maximum of four rolling operations have had been performed in a day. The average load in the rolling machine is 91.02 Kg., whereas the British-made rolling machine has been prescribed to perform at a capacity of 80 Kg. per rolling. This machine is operated by diesel plant and it rotates at a speed of 1 cycle/second when weathered input is loaded. The summary of the rolling performance is as follows (Please refer to Annex - I for its detail.):

Mean load	=	91.02 Kg.
S.D.	=	17.45 Kg.
Load Range	=	60 Kg. to 125 Kg.
Load Setting Time Range	=	9 minutes to 21 minutes

Figure - 2: Shrinking Trend of Green-Leaves Preceding Rolling Process



LOAD PRACTICE IN ROLLING

Table -1 below summarizes the characteristics of loads in rolling machine observed in the factory. Both the first rolling and second rolling represent equal share (31.91 percent each) of the total number of rolling performed, while the third and fourth rolling are carried out in 25.53 percent and 10.64 percent respectively. The highest dispersion of loads is found in the third rolling (17.24 Kg.) whereas the least dispersion is found in the fourth rolling (12.04 Kg.). The mean load of rolling machine is the highest (97.13 Kg.) in the first rolling. The mean load decreases in the second, third and fourth rolling, which are 96.80 Kg., 82 Kg. and 77 Kg. respectively.

Table - 1: Characteristics of Rolling Loads

Rolling	First	Second	Third	Fourth
No. of Rolling	15	15	12	5
Input Rolled (Kg.)	1457	1452	984	385
Mean Load (Kg.)	97.13	96.80	82.00	77.00
S.D. (Kg.)	16.03	15.90	17.24	12.04
Load Range (Kg.)	60 to 120	70 to 120	65 to 125	60 to 90

Source: Observed data.

STANDARD EEROR AND ACCEPTANCE LIMIT FOR Z-TEST

Computations of the standard error of the mean and the upper level of acceptance region of loads for z-test have been obtained with the following methods:

Std. Error of the Mean	=	$\sigma / \sqrt{N}$
	=	$17.45 / \sqrt{47}$
	=	2.55 Kg.

Upper Level Acceptance Limit = H_0 + (Standard Error of the Mean × Value of Alpha from Z-table)

= 80 + 2.55 It should be 2.33 (one - tail z-value)
85.94 Kg. (for 0.01 level of significance)
83.26 Kg. (for 0.10 level of significance)

Similarly,

At one-percent significance level, the null hypothesis is rejected in right-tailed z-test since there is no statistical evidence to accept it. Therefore, it is obvious that in the peak season there is no capacity conformance in the rolling performance.

CAPACITY CONFORMANCE RATES

It is found that number of rolling within clear capacity loads is 15 rolling out of 47 observed in this factory. This gives a clear conformity rate of 31.92 percent. Computation of clear conformity rate excludes all rolls that perform with more loads than the load prescribed by the facility design. Basket method gives 34.04 percent capacity conformance rates, which is based on samples falling within acceptance limit (84.18 Kg.) at ten percent significance level by right-tailed z-test. Rates mentioned above are simply the proportion of accepted lots to total lots expressed in percentage. For example,

Clear Conformity	=	Rolling within prescribed Capacity/Total Rolling Observed × 100
	=	15/47 × 100
	=	31.92 Percent
Basket Conformity	=	Rolling Accepted in Basket Method/Total Rolling Observed × 100
	=	16/47 × 100
	=	34.04 percent

Considering the current practice of dose administration in the rolling machine on the one hand and the supply of green leaves during peak plucking season on the other, the capacity conformance rate may be lower than those calculated above. The ground for this indication is that the total weight of a day's weathered leaves is first estimated without actual measurement, and is only actually measured when allocating to rolling machine. Such subjective allocation of load becomes problematic. There is no scope for adjustments in case any rolling receives inputs that are out of rate of the plant's prescribed capacity. The fourth rolling has the highest clear conformity rate - 60 percent - simply because previous rolls are over loaded and the residual material's load have been allocated to the same. Thus, rather than other reasons, the load feeder's job behavior impedes capacity conformance in the rolling machine to a great extent. Table - 2 and Table - 3 respectively show the basis for computing clear conformity rate and basket conformity rates of load practiced in this factory.

Table - 2: Clear conformity (Exact Conformity) of Load reflected at Rolling Workshop

Rolling	Number of Rolling Within Capacity Limit	Number of Rolling Beyond Capacity Limit
First	3	12
Second	3	12
Third	6	6
Fourth	3	2
Total (15+32 = 47)	15	32

Source: Observation.

Table - 3: Basket Conformity of Load Reflected in Right-Tight-Tailed Z-Test at Alpha Ten Percent

Rolling	Number of Rolling in Acceptance Region	Number of Rolling in Rejection Region
First	3	12
Second	3	12
Third	7	5
Fourth	3	2
Total (16+31 = 47)	16	31

Source: Observation.

TEST OF GOODNESS OF FIT

Loading data of Table- 2 and Table - 3 into computer-based SPSS indicate that acceptance and rejection rolling are insignificant. Therefore, clear load conformity rate and basket load conformity rate of this factory (which is calculated on the basis of the same) are normal since linear-by-linear association values of chi-square are 0.22222 and 0.39414 respectively. These values are substantially lower than the tabulated values at 1 DF at 10 percent significance level. Analysis of above tables, however, reveals six cells with expected frequency less than five allowing for a probable risk of misinterpretation of chi-square results (Elhance, Elhance & Aggrawal 1997: 24. 24; Levin & Rubin 1998: 578). But programmed operation of Yate's corrections and cell adjustment factors in the SPSS for Windows for these cells provide relatively wider scope for making good interpretation. (Please turn to Annex-2 for SPSS chi-square output.)

DISCUSSION

The machinery capacity is a standard that is devised to control overflow of input to avoid wastage and minimize the rate of possible accidents and hazards at the workplace. In addition, the capacity also provides a criterion for measuring how well an employee performs for the organization maintaining quality of work life on his/her part. The needs to maintain a high level of conformity to prescribed capacity in manufacturing units are omnipotent for productivity improvement. This is an aspect largely ignored in this particular factory. Ability to conform to capacity in operations has multi-dimensional effect for the growth of enterprises. Capacity conformance is necessary to avoid wastage in a normal production function because input-output transformation process has a tendency to incur wastage of one or other the kind. It could also be due to low capacity utilization, unbalanced capacity positions and differential match points of production factors (Adhikary, 1999: 31). Monthly payments made to employees when the factory was idle are also a kind of wastage.

Quality of a product is seen as a function of how well the product/service conforms to a design of specification (Gilmore, H.L., 1974: 16, Haizer & Render 1991: 300). The specification set by the plant designer should conform to perform production runs if the industry wants to improve the quality of its outputs, because capacity conformance is important for Total Quality Management (QM) as well. In the US and Japan, TQM is viewed from the same angle in that they believe quality depends on all departments- from purchasing to engineering design to production to shipping to services (Haizer & Render, 1991: 743). Therefore, if there is capacity conformance in rolling operation, it is likely to enhance total quality of this factory.

There is no doubt that specification also includes standards, capacity conformance, etc. It indicates that each process of a production unit should meet specifications of capacity, raw material, process, tools, quality, etc. in the tea industry, as it should in other industries. Although this aspect is found to be very poor in the rolling performance, there is perfect conformance in the temperature maintained in weathering processes. The term capacity is defined as the maximum output of a system. There are three major terms of capacity in operations management, i.e., designed capacity, rated capacity and utilization capacity (Ibid: 11). This study uses clear conformity and basket conformity to measure the capacity utilization status, which are less theoretical compared to the three terms of capacity discussed above. Basket conformity rate computed at ten-percent significance level is found higher than clear conformity rate when overall sample statistics reject null hypothesis at one-percent significance level. It should be higher whether the null hypothesis is rejected or is accepted, because this method accepts individual sample falling within acceptance limit which is ascertained to accept a sample mean in hypothesis testing.

Lack of skilled work force has been ranked as the biggest macro level factor negatively affecting productivity (Survey Report on Productivity Awareness in Nepal, 1996: 19). Beside this, the present study indicates, in the micro level, that it is largely job behavior related disciplinary problems. Workers' tendency to quit work as early as possible and neglect of available equipment is reflected in the factory. This indicates that adequate kill, tools and resources are useless for higher productivity unless workers utilize the same. The factory had provided appropriate weighing equipment to weight weathered tea-leaves and calculators to calculate the weights. The workers have the skilled to use that equipment, but they do not utilize them when required. It is the job behavior of the employees nonetheless. For example, if their skill and equipment were utilized as much as it was necessary for performing jobs correctly, chances are that additional sample loads could fall within the acceptance region thus increasing conformity position (rates).

Capacity is the maximum load of any machinery to perform best, and it is suggested that a maximum of 70 percent load should be aimed for in the first place (Muhlemann, Oakland & Rockyer, 1996: 328). This rate can be modified for the short term by operating facilities more or less intensively than normal capacity (Everette & Ebert, 1997: 168). Whereas, the observed data revealed that during rolling operations, there was a general practice of loading the machinery with as much as 150 percent of its prescribed capacity. This is too much for a safe operation of machines and equipment. Thus, this study also indicates that mismatch of capacity of plants and machinery at workshop is one reason for intensifying the need for a monster-repair work. The researcher believes that clear conformity rate above 65 percent and basket conformity rate above 70 percent should only be considered as satisfactory level in manufactories.

CONCLUSION

NULL HYPOTHESIS IS REJECTED

The sample mean 91.02 Kg. with the standard deviation of 17.45 Kg. falls in the rejection region of the normal curve when Z-test is applied. Therefore, it is concluded that operations in Ilam Tea Estate do not conform to the capacity prescribed by the plant designer while processing tea in the rolling machine during the peak season. Obviously, at one-percent significance level, the null hypothesis is rejected since there is no statistical evidence to accept it. When a null hypothesis is rejected at low significant levels, there seems to be no grounds to be optimistic for the same to be accepted at other higher levels.

CONFORMITY RATES ARE NOT BY CHANCE

The capacity conformity rates (i.e., clear conformity and basket conformity) indicate that the number of accepted and rejected rolling, which are the basis of computing these rates, in the peak season are not by chance. Therefore, it is found that they are insignificant when the values of alpha testing hypothesis for chi-square tests are taken at 10 percent each.

LOW CONFORMITY RATES ARE ASSOCIATED TO JOB BEHAVIOR

The incongruence in machinery designer's prescription and practiced loads in the workshop is a behavioral disciplinary problem of this manufacturing unit. If this situation continues, the capacity conformance rate may shrink further.

RECOMMENDATIONS

DOORS FOR IMPROVING EVERGREEN CONFORMITY IS OPEN, PASS THROUGH IT

The unavailability of sufficient input material during off-season (especially during the beginning and ending months) may affect the conformity position to some extent. However, such a situation may be considered as one of the production constraints. The sample data shows that there is ample scope to increase the capacity conformance rate in the peak season simply by extending the number of rolling instead of the prevailing practice of having maximum four rolling. This technique, however, may not be practical for periods other than the peak season due to low quantity of weathered-leaves supplied to rolling performance. Therefore, a practical approach incorporating the *Kaizen* concept towards continuous improvement of the conformity position for Total Quality Management requires that the following suggestions be followed:

1. First of all, measure the weights of the total lot of weathered-leaves of a day extracted from the trusses.

2. Based on the total weight, decide and allocate input loads for rolling-machines.

3. Ensure that the previous rolls meet or be as close to the prescribed capacity as possible. The last roll should maintain stocks fairly below the capacity load (as it is practiced during beginning and ending months of plucking season) to perform rolling on the subsequent day, or

4. Perform rolling on the same day adjusting normal 45 minutes for pressure on and off only for the last rolling if the load is too small in order to save the top part of tea bud for sorting.

5. Whenever possible, do not perform rolling if the weight of weathered leaf is less than 30 Kg. for one rolling, i.e., when the original green-leaves are about 94 Kg. (performing with loads less than 30 Kg. will not

decrease the conformity positions of this factory but will make rolling more costly. Considering a time range of 9 to 21 minutes for load setting and resetting from the weathering truss and additional 45 minute of *Takt* time applied to perform one rolling, loads with less than 30 Kg. necessitates overtime work.)

CORRECTION OF PROBLEM RELATED TO JOB-BEHAVIOR

Lack of capacity conformity at work is a job-behavior-related disciplinary problem that needs to be corrected before it invitees a catastrophic situation. Failing to conform to capacity prescription at work may lead to numerous negative consequences to the factory, which may jeopardize productivity, decrease quality of the processed tea, increase the rate of machinery breakdowns, and, simultaneously, the maintenance cost is inherent to hike for the same reason. Quality supervision at workshop and effective carrot and stick system followed by OJT program are desirable to improve this worsening situation to regress further.

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ANNEX - 1

Table - 1: Rolling Loads Applied at Workshop

S.No.	Load of Weathered Tealeaves (in Kg.)				Day's Total
1.	110	110	125	-	345
2.	90	90	-	-	180
3.	80	70	72	-	222
4.	87	87	82	-	256
5.	80	80	65	60	285
6.	90	100	85	80	355
7.	105	110	100	90	405
8.	60	70	-	-	130
9.	100	90	70	-	260
10.	115	115	-	-	230
11.	100	100	70	70	340
12.	100	90	85	-	275
13.	110	110	75	-	295
14.	110	110	90	85	395
15.	120	120	65	-	305
Rolling at Work	First	Second	Third	Fourth	Day's Total

Table - 2: Imperature Conformance Character (Temperature Supplied to Weathering Trusses)

Mean Temperature	Standard Deviation	Temperature Range	Sample Size (lots)
84° F	3.3° F	75°F to 91° F	37

Source: Observation.

Table - 3: System of Orthodox Grading

Quality Rank	Quality Code Applied in Grading
1	SFTGFOP
2	FTGFOP
3	TGFOP
4	GFOP
5	FOP
6	TGFBOP
7	GFBOP
8	BOP
9	OF
10	PD
11	BT

Source: DMT Sorting Department, 2000.