Comfort Analysis of Labour during Different Tea-Leaf Harvesting Practices

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ABSTRACT

Labour shortage and drudgery involved in tea harvesting is imposing it'smechanization. However, evaluation of the human performance has great importance for the adaptations of new designs.In this research,two mechanically assisted tea-harvesting methods were evaluated against traditional manual tea plucking from ergonomic point of view. It was found that during all operationsheart rate of a labourincreased at faster rate in the beginning of the experiment, then stabilizedfor certain time of operation and finally reached to maximum value when labour felt tired. Labours indicated their fatigue after 30, 25 and 35 minutes of operation in manual, shear assisted and motorized shear assisted harvesting methods, respectively. Moreover, average heart rate values and oxygen consumption rate were observed lowest for motorized shear cutter assisted harvesting compared to those of shear assisted harvesting and hand plucking. In conclusion, motorized hand shear was found to be easing tea harvesting operation with increased comfort.

Key words : Tea harvesting, motorized shear cutter, comfort analysis, heart rate, oxygen consumption

INTRODUCTION

Agricultural field activities had always been vulnerable to immediate fatigue with very less control over work environment. Tea cultivation is not exception for it. Activities starting from field preparation to harvesting are tedious and very much prone to physical and/or mental weariness.

Tea in India has a long history of consumption as well as application in traditional system of medicine. India and China are the largest producers as well as the consumers of tea. About 77% of tea produced in India is consumed in India itself [1] Tea industries are playing a vital role in the economic development of tea growing states, and tea production is increasing over the years [2]. However this increase in production is largely due to the adaptation of advanced cultural practices and to a lesser extent due to the marginal increase in the area under tea cultivation [3]. Moreover, number of tea estates are increased, however labour strength has not increased in proportion (Fig 1); conversely it has been drastically reduced (Fig 2) [4].

The primary reason may be the drudgery involved in the work; especially during harvesting operation labour has to work under extreme conditions. This altogether resulted in shortage of labours and increase in the wages. In-turn, it is resulting in big loss, since tea leaves are not harvested on time.Consequently tea industries inducted mechanization of tea leaves harvesting to overcome labour scarcity problem and increase the harvesting capacity. Some of the south Indian tea estates have adopted locally manufactured shear cutters [6], while researchers have introduced motorized shear cutters to ease tea-harvesting and increase productivity of the labour. Primary observations of the labours using these devices indicated increased harvesting capacity of individual labours [7]. However, scientific evaluation of human performance is necessary for the rightful adaptation of this mechanization.

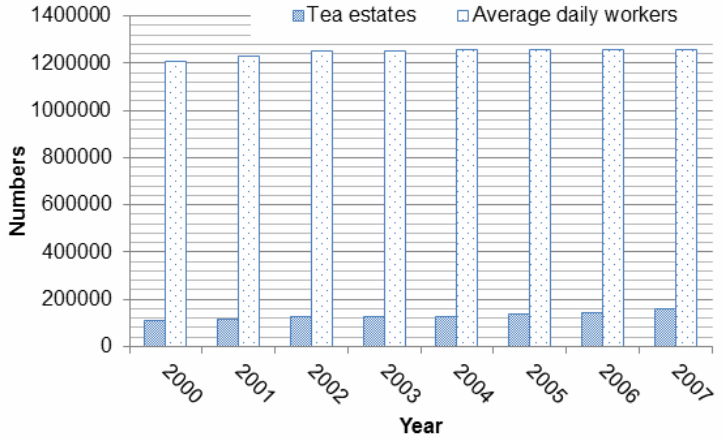

Fig 1: Status of tea estates and labours [5]

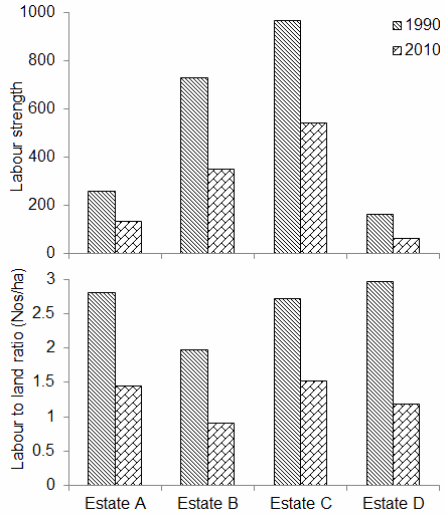

Fig 2: Reduction in labour strength of tea estate (Radhakrishnan et al., 2012)

Till date, very few or almost no research data is available on ergonomic evaluation of the labours during tea-harvesting. In addition, there is no any comparative quantification of comfort achieved by adaptation of mechanization in tea harvesting. Hence in this project, three tea-leaf harvesting practices namely manual plucking, hand shear assisted harvesting and motorized shear cutter assisted harvesting were ergonomically evaluated to understand the labour ease during these activities.

MATERIALS AND METHODS

Three types of tea-leaf harvesting methods namely, hand plucking, hand shear and motorized shear cutter assisted harvesting (Fig 3) were evaluated for understanding level of comfort during each operation. Five male operators of different age were selected such that their BMI (body mass index) appear within normal range (Table 1). A polar heart rate monitor was used to measure the heart rate of labour during operation.Before starting the actual operation, subject was asked to operate for 10 min. It was done for warming up of the subject. Then a 5 min rest was given and then harvesting operation by each method was carried for 40 min duration (Fig 5). Polar heart rate monitor was set to collect the heart rate data for every 5 seconds during continuous harvesting operation. During each operation, subject was asked to stop when they felt the tiredness. Measured hear rate date was transferred to computer by using polar precision software.Eachlabour asked to do the same operation three times and average heart rate values were calculated.

a) Hand shear b) Motorized shear cutter

Fig 3: Equipment for tea harvesting

Table 1: Basic body dimensions of selected operators

Subject	Age (year)	Weight (kg)	Height (cm)	BMI (kg/m^2)
A	24	52	163	19.57
B	27	47	165	17.26
C	32	62	160	24.21
D	38	49	167	17.56
E	45	58	162	22.10

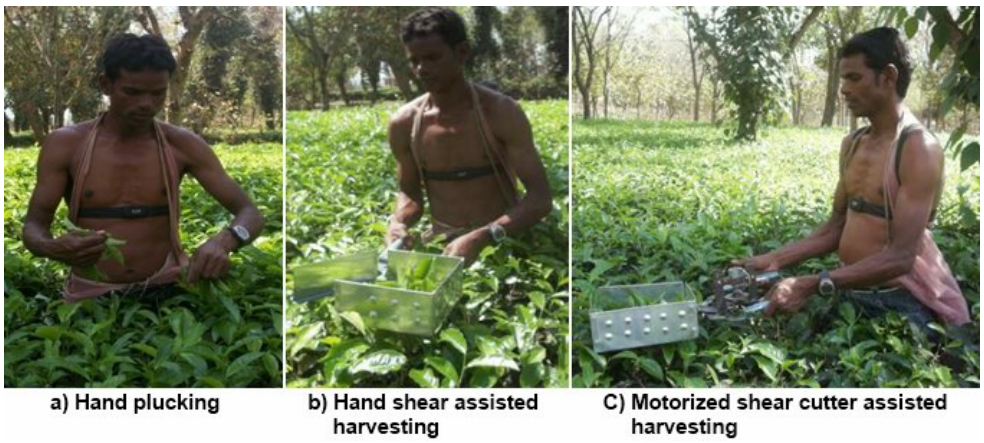

Fig 4: Tea-leaf harvesting methods

Observed heart rate values were used as an index for analysing comfort of the labours during respective operations.Subsequently using heart rate values oxygen consumption rate i.e. amount of oxygen consumed by the whole body per unit timeand energy expenditure rate were calculated.

RESULTS AND DISCUSSION

Physiological performance of the labours during respective tea-leaf harvesting operationswas evaluated in terms of the average heart rate observed over respective time of operation (Fig 5-7). During all operations heart rate of a labour increased at faster rate in the beginning of the experiment, then increased with stable ratefor certain time of operation and finally reached to maximum value when labour felt tired. All labours under same operation presented same performance, while it differed for different harvesting operations. Labours indicated their fatigue after 30, 25 and 35 minutes of operation by manual, hand shear assisted and motorized shear assisted harvesting, respectively.Moreover, average heart rate of all labours was observed higher during hand shear assisted harvesting operation, followed by manual harvesting and motorized shear assisted harvesting.

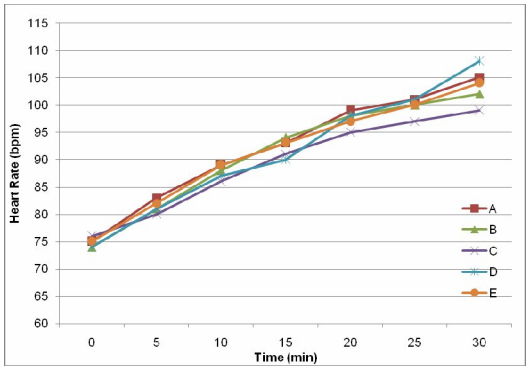

Fig 5: Heart rate during hand plucking

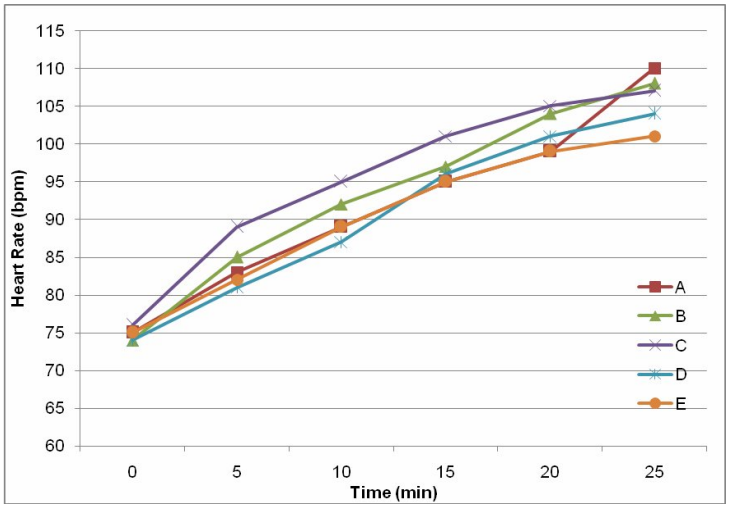

Fig 6: Heart rate during hand shear assisted harvesting

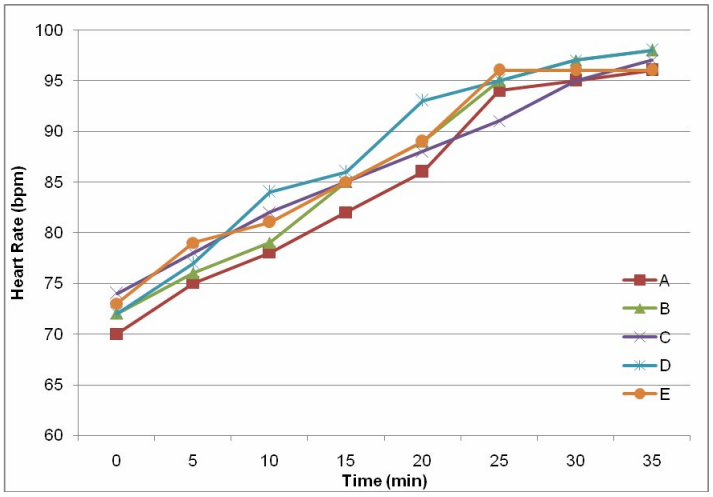

Fig 7: Heart rate duringmotorized shear cutter assisted harvesting

This can be explained by the number and complexity of the actions involved in respective operations. For instance, during manual harvesting, labour has to first identify the appropriate leaf, then pluck and carry it to a bag on his back. Also he has to carry the load of harvested leaves on his back. On other hand, during hand shear assisted harvesting, all actions remain in operation except plucking, which is replaced by shear cutting. However during this shear cutting, labour has to do continuous reciprocating shear action, consequently labour gets early fatigue. Conversely, in motorized shear assisted harvesting, mechanized cutting action present great relief to labour and as a result labor has to only lead this device to desired leaf and finally has to carry the accumulated leafs in collection tray to the bag on his back. Moreover, oxygen

consumption rate (OCR, L/min) and energy expenditure rate (EER, kJ/min) were observed in tandem with average heart rate values, because of these different actions involved in respective methods (Fig 8 and 9). Variationin OCR and EER among different labours is because of their different BMI, indicating their health.

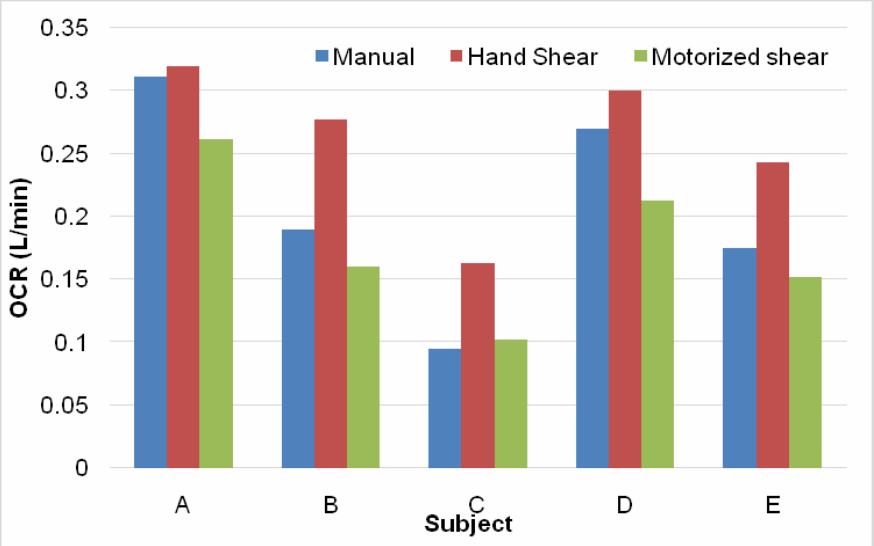

Fig 8: OCR (L/min) of labours during different tea-leaf harvesting operations

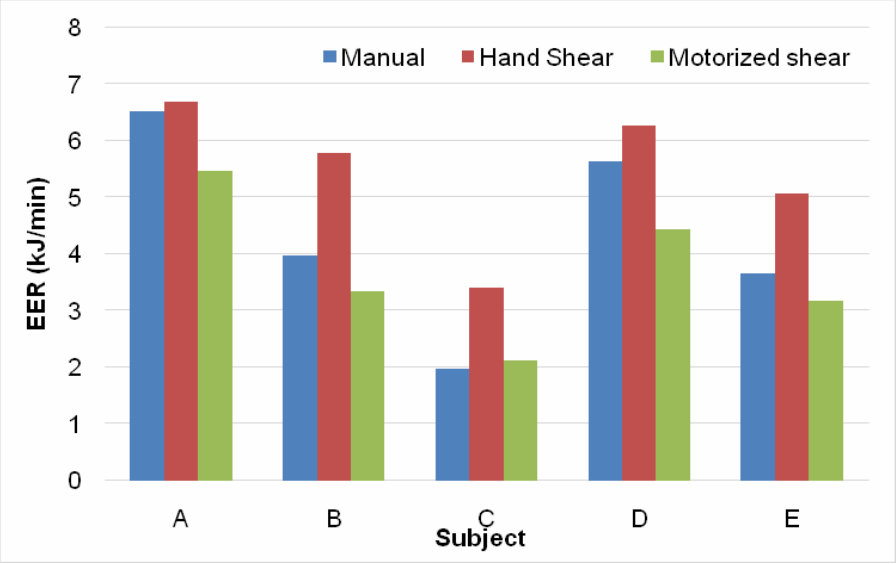

Fig 9: OCR (L/min) of labours during different tea-leaf harvesting operations

CONCLUSISONS

Manual harvesting is advantages in terms of work quality, but labour scarcity and lower capacity are major concerns about this method. Scarcity is mainly because of drudgery involved and low returns.

In this study, it was found that motorized shear assisted harvesting method presented longer time of operation compared to manual and shear assisted harvesting methods. Moreover, average heart rate values and oxygen consumption rate were observed lowest for motorized shear cutter assisted harvesting compared to those of shear assisted harvesting and hand plucking.

In conclusion, motorized hand shear was found to be easing tea harvesting operation with increased comfort.

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