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Research Paper

An ergonomic study on traditional and modern tools used for vegetable plucking activity

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ABSTRACT : Women in rural India play a major role in shaping the economy of the country. They participate in different production and post production agricultural operations. But no mechanization has been introduced for farm women dominated farm operations to reduce their drudgery at work. Therefore, under All India Coordinated Research Project (AICRP) on Home science of Indian Council of Agricultural Research, New Delhi on ergonomic evaluation of vegetable plucking activity (especially cucurbitaceous family *i.e.* Bottle Gourd, Ridge Gourd and Palmyra fruit) was done by taking 30 farm women in the age group of 21-35 years by using both traditional (ordinary knife) and improved hand tool (ring cutter). The ergonomic tsudt was done in the vegetable fields by using Standard Ergonomic Technique by using physiological (heart rate, energy expenditure, physiological cost of work and cardiac cost of work) and muscular parameters (grip strength and musculoskeletal problems). Ergonomic assessment of both the methods showed that by using ring cutter, physiological and muscular stress of workers in terms of heart rate, energy expenditure, total cardiac cost of work, physiological cost of work and grip fatigue were reduced as compared to traditional method i.e ordinary knife. Therefore, this new handy tool is found beneficial to improve work efficiency of farm women.

KEY WORDS : Ergonomic evaluation, Physiological cost of work, Muscular stress, Energy expenditure, Grip fatigue

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Rural women in developing countries like India are potentially involved in farm and allied activities. They are employed mostly in drudgery prone activities which include transplanting, weeding, harvesting, grain cleaning, storage etc (AICRP, 2009). The tools/ implements available have been primarily developed for male workers and given for use to women workers which result in less efficiency and occupational health problems. This is due to the reason that women have different physical needs than men due to their anthropometric requirements, education, experiences, skills etc. Therefore, the major step in the present time is to modify the design of old technology which can help to reduce their drudgery and increase work efficiency.

Keeping in view the above criteria, an attempt has been made under All India Coordinated Research Project (AICRP) on Home Sience of Indian Council of Agricultural Research (ICAR) New Delhi to do the ergonomic study on vegetable plucking activity by using traditional tool (ordinary knife) and newly introduced modern tool (ring cutter).

RESEARCH METHODS

Ergonomic assessment of vegetable plucking activity (especially cucurbitaceous family *i.e* Bottle Gourd, Ridge Gourd and Palmyra fruit) with traditional and modern hand tool was done by using standard ergonomic techniques given by (Oberoi and Singh, 2007). A sample of 30 rural women for vegetable plucking activity in the age group of 21-35 years were taken and the health status of the selected women involved in the experiment was assessed by using the following parameters given by Oberoi and Singh (2007).

Health status :

Health status of farm women (respondents) was assessed by using following parameters.

– Body type/composition
– Body Mass Index (BMI)
– Physical fitness
– Aerobic Capacity (VO_2)

The following parameters were used to do the ergonomic evaluation of vegetable plucking activity.

Heart rate	Polar heart rate monitor
Energy expenditure	0.159 X heart rate (bpm)-8.72
Total cardiac cost of (TCCW)	CCW + CCR (Cardiac cost of work work+Cardiac cost of recovery)
Muscular fatigue	Grip dynamometer and pinch dynamometer

Ergonomic evaluation of selected activities involved the following parameters:

Heart rate (resting, working and recovery) Beats /min

Energy expenditure = 0.159 X heart rate (bpm) -8.72

Total cardiac cost of work = CCW + CCR

Cardiac cost of work (CCW) = (Average working heart rate- Average resting heart rate)X Duration of activity

Cardiac cost of recovery (CCR) = (Average recovery heart rate- Average resting heart rate) X Duration of activity

$$\text{Physiological cost of cost} = \frac{\text{T.C.C.W.}}{\text{Total time of work}}$$

Muscular parameters = Grip fatigue

■ RESEARCH FINDINGS AND DISCUSSION

Ergonomic Assessment of ring cutter used for plucking of vegetables under vegetable growing enterprise.

Under the objective of "Technology interventions for drudgery reduction in rural enterprises", vegetable growing enterprise was selected. The indepth analysis of work process was done and vegetable plucking activity was found as the drudgery prone activity. For reducing the drudgery a tool i.e ring cutter was developed to pluck the vegetables especially bottle Guard (*Ghiya*), ridge guard (*Tori)* and Palmyra Fruit (*Tar*) from the fields. The ergonomic evaluation of ring cutter was done by using the Standard Ergonomic Technique which has been discussed in Materials and Methods chapter. The results of above assessment has been discussed below.

Data given in the Fig.1 show that the women involved in vegetable plucking activity have mean age 34 years; height 155 cms; gross weight 56 Kgs; Lean Body Mass 45 Kgs; Body Mass Index 25 and VO_2 (ml/Kg x min) 33. On the whole, it was observed that more young women were involved in vegetable plucking activity as this activity is perceived as tiring and difficult to perform by old women.

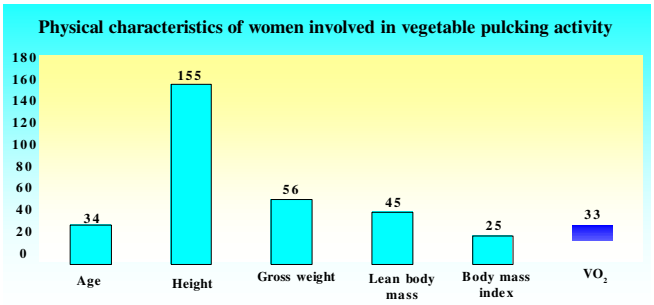

Fig. 1: Physical characteristics of women involved in vegetable plucking

Health status of respondents:

Health status of the women involved in vegetable plucking activity was assessed on the basis of body type, Physical Fitness Index (PFI) of the subject, VO_2 and Body Mass Index (BMI). The results are highlighted as below:

Fig 2. shows that maximum of the selected women (78%) had mesomorph body type indicating that they had athletic body with well developed musculo-skeletal system.

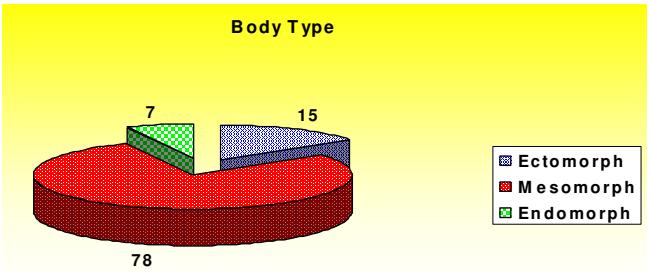

Fig. 2 : Body composition of respondents

Fig. 3. indicates the health status of respondents as per Physical Fitness Index scores given by Varghese *et al.,* 1995. It was observed that maximum number of women were having Physical fitness of high average category followed by good and low average category.

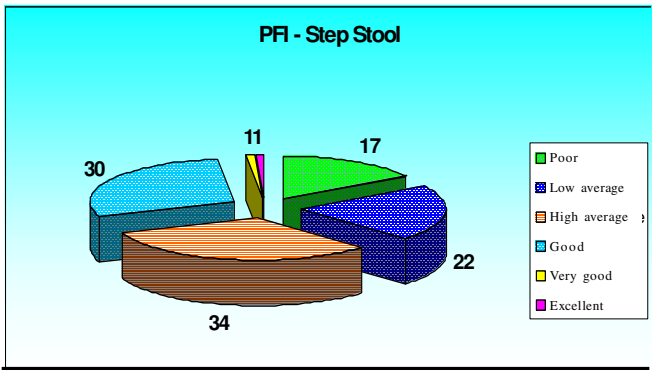

Fig. 3 : Physical fitness index- step stool

Physical Fitness Index – Fig. 4 shows the aerobic capacity of respondents on the basis of Physical Fitness Index VO_2. It was found that maximum number of respondents (33%) were having aerobic capacity of high average category followed by good (30%) and very good (20%). Only 7.0 per cent of respondents had poor aerobic capacity.

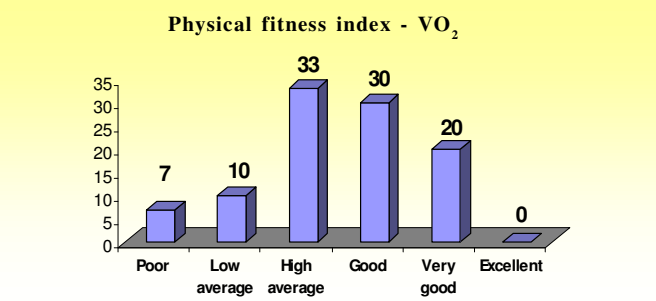

Fig. 4 : Physical fitness index-VO_2

Fig 5. shows that maximum of the rural women belonged to the category of normal body mass followed by obese grade I, critical energy deficiency grade II, critical energy deficiency grade I and low weight. There was no respondent who belonged to the categories of obese grade II and CED grade III.

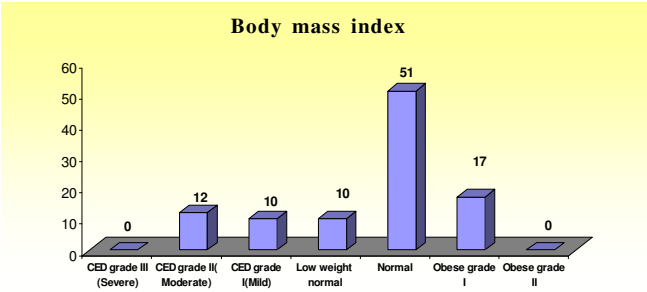

Fig. 5 : Body mass index

Therefore, it can be concluded that on the whole, the health status of the selected subjects was good and they were not having any major health problem which reduces their work efficiency.

Ergonomic assessment of vegetable plucking activity in terms of Average and Peak Heart Rate, Average and Peak Energy Expenditure were calculated and are shown in Table 1. It was observed that values of Average and Peak Heart Rate as well as Average and Peak Energy Expenditure were very high. When the selected activity was performed with the traditional method as well as with the use of new developed ring cutter. However, with the use of new tool developed for vegetable plucking the significant reduction in the values of heart rate and energy expenditure were observed. The total cardiac cost of work and physiological cost of work of selected activity was found higher with the use of traditional method as compared to improved method. Therefore, it can be concluded that with the help of ring cutter, the physiological stress of the worker can be reduced significantly as compared to the traditional tool used for vegetable plucking *i.e.* ordinary knife.

Muscular stress :

It was measured in terms of percentage change in grip and pinch strength with the help of grip dynamometer and pinch dynamometer respectively. Grip strength (Fig. 6) shows that by using improved tool, the grip strength was increased

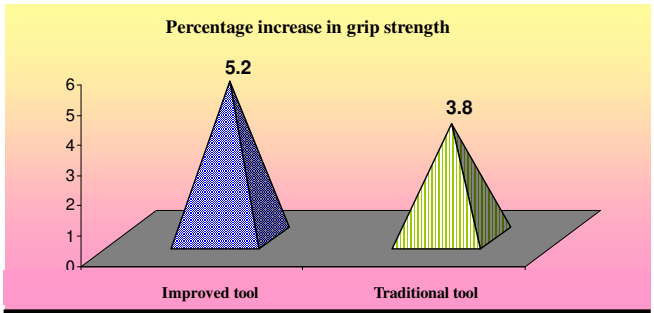

Fig. 6 : Percentage increase in grip strength

Table 1: Ergonomic assessment of vegetable plucking activity using traditional and improved tool

Parameters of ergonomic assessment	Traditional tool	Improved tool	Percentage change* with the use of improved over traditional tool
Average working heart rate (Beats/min.)	122	110	9.83↓
Average peak heart rate (Beats/min.)	128	120	6.25 ↓
Average energy expenditure (Kj/min.)	9	7.29	1.90↓
Peak energy expenditure(Kj/min)	9	8.8	2.20↓
Average TCCW (Beats / min.)	620	480	22.5↓
Average PCW (Beats / min.)	20	16	20↓

* Percentage change – $\frac{\text{Traditional tool – Improved tool}}{\text{Traditional tool}} \times 100$

as compared to the traditional tool. Women did not feel grip fatigue while using ring cutter due to its design. Therefore, the use of ring cutter can be recommended as it helps in increasing the grip strength of women workers.

Table 2 shows the reduction in pinch fatigue in terms of tip, key and palmer pinch. In all the three types of pinch, the fatigue reduction was observed when the improved tool (ring cutter) was used as compared to traditional tool (ordinary knife) while performing vegetable plucking activity.

Table 2 : Reduction in pinch fatigue while performing vegetable plucking activity

Type of Pinch	Traditional tool	Improved tool	Percentage reduction in pinch fatigue
Tip	5.0	6.5	30
Key	6.0	6.5	8.33
Palmar	6.5	8.0	23

Fig.7 Average incidence of Musculo- skeletal pains during vegetable plucking with the use of traditional and improved tools.

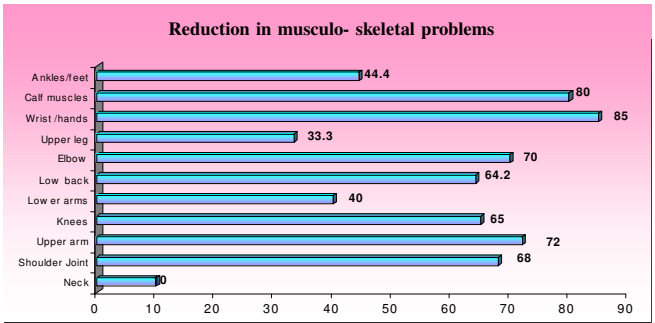

Fig. 7 : Reduction in musculo- skeletal problems

The results of average incidence of Musculo-skeletal pains for performing the selected activity. Incidence of musculo- skeletal pains was also measured on five point scale ranging from very mild to very severe pain. It was found that respondents felt severe pain in wrist, calf muscles, upper arm, shoulder joints and lower back. It may be due to the reason that they have to hold the vegetables in their hands till the vegetable plucking of one row gets completed. Pain in calf muscles and low back may be due to the fact that the respondents had to change posture frequently to find the vegetables from the creepers in the fields.

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