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Need of Mechanized Interventions in Selected Farm Operations in Finger Millet Cultivation in Tribal Hill Areas of Odisha

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ABSTRACT

Millet is one of the oldest human foods and is important food for sustaining tribal population in Koraput region of Odisha. The declining trends indicate the reduction in millet production in these regions as well. One of the main reasons for less popularity of finger millet is that they are labour intensive and require difficult post-harvest operations. In comparison to other major cereals, it requires high labour input mainly during transplanting, weeding, harvesting, threshing and grinding. For present study, two ragi producing tribal villages from hill tracts of Koraput district were selected randomly. Out of the selected villages, thirty women involved in ragi production were selected and interviewed for ascertaining the gender differentials in ragi cultivation and drudgery experiences. Experimental data was collected for 12 farm women in the age group of 30-45 years involved in ragi cultivation for five years. Need for technological and educational interventions is emphasised.

Keywords: Discomfort, Drudgery, Energy expenditure, Ergonomics, Manual threshing

INTRODUCTION

Small millets have consistently been an important and nutritious part of the diets of small-scale farmers and indigenous groups. Millet is one of the oldest human foods and is important food for sustaining tribal population in Koraput region of Odisha. Koraput district is a hilly region of 8807 square kilometres located in the southwest part of Odisha State at the northern end of the Eastern Ghats range. Ragi, a staple food grain for the rural population of Koraput District, has been cultivated here for thousands of years. Ragi is cultivated on 74,300 hectare, another 24.7 per cent after Paddy. But slowly the trend shows decrease in ragi production in this area. The declining trends indicate the reduction in millet production in these regions as well. One of the main reasons for less popularity of finger millet is that they are labour intensive and require difficult post-harvest operations. In comparison to other major cereals, it requires high labour input mainly during transplanting, weeding, harvesting, threshing and grinding. This increases the workload of farmers, especially women, throughout the whole process of cultivation and preparation of finger millet food items. Even many farmers are either declining or leaving the production of finger millet because of the drudgery experienced in the whole process. The other reason is technological negligence these millets face. Nutritious millets are neglected in all respects including technology development for grain processing. There is no efficient technology for processing these grains at village level, despite India producing about two million tons of these grains. Such lack of technology has been forcing the dependence on traditional methods of grain processing, which are tedious, time consuming and cause of drudgery for women. The small seed size also makes processing of the crop difficult and time consuming. The drudgery faced by the farmers and the returns on investment are among the major constraints for declined interest towards finger millet farming.

Against this backdrop, the study on assessment of drudgery in finger millet post-harvest operations is taken up. The study intended to study: i) the role of women in finger millet cultivation activities, ii) to assess the drudgery involved in finger millet production, and iii) to carry out physiological and biomechanical evaluation of finger millet production activities. In the present study, field visits were

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made and information was collected in participatory mode, to assess the drudgery involved in finger millet production, which is a major cause for disenchantment of farmers from this pro-poor, pro-nutrition crop.

MATERIALS AND METHODS

Selection of subjects: For present study, two ragi producing tribal villages from hill tracts of Koraput district namely *Gheuria Guda* and *Kandul Guda* were selected randomly. Out of the selected villages, thirty women involved in ragi production were selected and interviewed for ascertaining the gender differentials in ragi cultivation and drudgery experiences. A total of 12 farm women in the age group of 30-45 years selected randomly for experimental data. Various tools and techniques were used for taking measurements and recording responses.

Recording of physiological parameters: Finger millet threshing, which was perceived as most drudgery prone activity by tribal women, was further evaluated on the basis of physiological parameters *viz.* Heart rate and energy expenditure. Before the start of each part of the selected activity, the resting heart rate of the respondent per minute for five minute was recorded. Then the heart rate at the interval of 30 minute while carrying out the activity was also recorded. Immediately after the completion of the activity, respondents were made to sit in relaxed position and recovery heart rate was recorded for 5 minutes at an interval of 1 minute each (or till the value reached resting value). Heart rate was measured by using Polar heart rate monitor (RS 800). The energy expenditure per minute was estimated from heart rate and the classification of work load was done as per Varghese *et al.* (1994).

Energy Expenditure (kj/min) = 0.159 x Average Heart rate (beats/min.) – 8.72

Recording of psycho-physical parameters: Rated perceived exertion is subjective expression of feeling of respondents towards light/heavy work being undertaken by them. It is based on physical sensations a person experiences during physical activity. Although it is a subjective measure, a person's exertion rating may provide a fairly good estimate of the actual heart rate during physical activity. In this study, a modified 5-point scale of perceived exertion was developed by Varghese *et al.* (1996) was used to calculate mean scores of physical fatigue.

Recording of biomechanical parameters: A pen and paper technique termed as Rapid Entire Body Assessment (REBA) was used to assess biomechanical stress involved in ragi threshing activity. This tool uses a systematic process to evaluate whole body postural musculo-skeletal disorder (MSD) and ergonomic design risks associated with job tasks. A single page form is used to evaluate required body posture, forceful exertions, type of movement or action, repetition, and coupling. A score is assigned for each of the following body regions: wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.

RESULTS AND DISCUSSION

Gender roles in finger millet production: Focused group discussions were held with women farmers on their participation in finger millet cultivation and post production activities (Plate 1). In Odisha, major activities performed by tribal farmwomen in finger millet cultivation were seed management (83.33%), cleaning the field (63.33%), weeding (86.67%), harvesting (80%), bringing crop to home (93.33%), threshing (63.33%), winnowing (83.33%), cleaning the grain (100%), storage (60%) and pounding/ taking to mill (100%). A benchmark study conducted in selected villages of Odisha by IDRC (2013) revealed that women participate in over 60 per cent of the activity related to production and postharvest crop handling in small millets. About sixty per cent farm women were involved in selling the produce either from farm gate or to middlemen. The post-production activities were done manually like harvesting done manually with traditional sickle and threshing being done in open fields on earthen ground with wooden log.

Plate 1: Focused group discussions with a section of farmwomen of Koraput

Finger millet post-production activities performed in traditional cultivation: Harvesting includes harvesting, transporting, staking and drying as sub-activities. The harvesting of finger millet crop takes place mainly during October to November in Odisha. After crop maturity, the matured panicles (ear heads) alongwith stalk are collected by cutting with the help of traditional sickle. The harvested panicles are gathered in a container, such as bamboo baskets (*tokri)* or polyethene bags, before heaping them in a convenient place. *Bhadi,* a special type of wooden structure, is used for staking stalk bundles near threshing yard. The threshing ground is prepared by applying cow dung slurry on the ground. When dried, the panicles are kept on ground and beaten with wooden logs in continuous fashion. The threshed grain is collected and sieved and then stored. Storage is done by keeping the produce over fireplace. Threshing is done in open fields on earthen ground leading to high levels of contamination with foreign matter composed of stones, soil and plant matter (Plate 2).

Hardship involved in traditional finger millet post production activities: The respondents were asked to rate the difficulty experienced in carrying out post production activities in finger millet cultivation as extremely difficult (3), moderately difficult (2) and easy (1). The weighted mean sores were calculated for each activity and ranks were assigned as per the difficulty perceived. Of all the post production activities, threshing was perceived as the most difficult task followed by winnowing, harvesting and pounding. Sreenatha (2010) also estimated that harvesting and threshing of crops consume about one-third of the total effort requirement of the production system. A study by Budihal (2007) opined that among the post-harvest activities, majority of the female labourers reported bundling and threshing activities as most difficult (51.52%, and 63.33% respectively), whereas, winnowing was expressed as difficult by 66.07 per cent, and most difficult by 33.93 per cent.

Plate 2: Sieving and winnowing of finger millet

Being ranked as the most difficult to perform activity (Table 1), ragi threshing was analysed further for drudgery assessment. A job is considered highly repetitive if the cycle time is 30 seconds or less. In threshing, it was recorded that women have to beat the finger millet panicles about 25 times in each minute with heavy wooden log.

Musculo-skeletal discomfort while threshing finger millet: Work related muscular stresses perceived by respondents while carrying out threshing activity were recorded by body map technique (Corlette and Bishop, 1976). The mean score of the pain felt by the respondents in threshing of ragi by traditional method was highest in the upper arm (7.26) followed by lower back (7.2), mid back (6.13) and shoulder (5.73). The pain and discomfort in legs was highest, whereas discomfort in buttock, thighs and upper back was comparatively low (Plate 3). This revealed that the workers suffered from pain and discomfort more in upper arm due to manual beating for a long duration, which also caused musculo-skeletal discomfort. The discomfort in lower back and shoulders were due to blending postures adopted by them at work place. In line with the fact documented by Miranda et al. (2012) women are reporting high perceived pain in various body alignments including low muscle mass and low bone mineral density. Further West Gaurd and Aaras (1985);

Table 1: Difficulty perceived in post-production activities of Finger millet cultivation (N=30)

S.No.	Activity	Extremely difficult (3)	Moderately difficult (2)	Easy (1)	Difficulty score	Rank
1.	Harvesting	23(77)	4(23)	3(10)	2.6	III
2.	Threshing	30 (100)	0(0)	0(0)	3.0	I
3.	Sieving/winnowing	26 (87)	3(13)	1(0)	2.8	II
4.	Pounding/Grinding	10(33)	1(20)	5(17)	1.1	IV

*Figure in parenthesis shows percentage

Plate 3: Traditional threshing of finger millet with wooden logs

Keyserling *et al.* (1988); Ryan (1989) and Burdorf *et al.* (1992) supported the above said facts by stating that poor body posture was the major cause of musculoskeletal disorders.

To study the psycho-physical aspect of drudgery in form of the subject's perception of exertion, they were asked to give ratings on a 10 point scale after completion of task. It was found that the mean rating of perceived exertion found to be 8.67 which further depicts that the task of threshing is perceived as heavy and very hard to carry activity by the respondents (Borg 1982).

Physiological response of subjects performing threshing activity: Heart rate of the subjects while carrying out threshing activity was used to assess drudgery involved as heart rate is a major parameter in quantification of drudgery (Astrand and Rodahl, 1977). Cardio vascular responses such as heart rate and energy expenditure with respect to working on existing working condition have been depicted in Table 2.

Table 2: Heart rate and energy expenditure while threshing finger millet

Subject	HR Beats/min (Working)	HR Beats/min (Rest)	HR Beats/min (Recovery)	EER KJ/min
1.	141.00	101	103	13.70
2.	153.90	98	101	15.75
3.	141.80	94	98	13.83
4.	137.82	97.16	96.3	13.19
5.	141.43	101	102	13.77
6.	134.41	77	81	12.65
7.	126.90	98	92.6	11.46
8.	122.12	86.3	85.37	10.70
9.	120.00	89	95.16	10.36
10.	114.23	99	110.2	9.44
Mean	133.36	95.046	96.46	12.48

The drudgery involved in finger millet threshing was quantified by taking heart rate measurements by polar heart rate monitor and calculating energy expenditure. A job is considered highly repetitive if the cycle time is 30 seconds or less (Siegfried, 2002). High task repetition, when combined with other risk factors such as high force and/or awkward postures, can contribute to the formation of MSD. In threshing, it was recorded that women have to beat the finger millet panicles 25 times in each minute with heavy wooden plank. During this, she adopts bending and squatting posture repetitively. The women did not use any tarpaulin or sheet on the ground while threshing which increases the contaminants and foreign substances in the grain, thus adding to drudgery in winnowing and cleaning grains. The drudgery is further accentuated with small husk particles released while beating which may cause respiratory problems.

The average working heart rate for finger millet threshing activity was found to be 133 beats per minute, with peak heart rate while working was observed to be 154 beats per minute. Total cardiac cost of work and physiological cost of work for finger millet threshing activity was found to be 1673 and 56 beats per minute, respectively. The average energy expenditure was found to be 12.48 kj/min thus classifying the activity as heavy one (Varghese *et al.,* 1994). The results are in concordance with the data on drudgery in ragi threshing in hills of Uttarakhand which also classifies the activity as heavy (Joshi *et al.,* 2014).

Analysis of working posture while performing ragi threshing activity: Ragi threshing activity performed by the hill tribe farming women were analysed with Rapid Entire Body Assessment (REBA) to determine the postural load and to categorize the potential harm involved due to the postures adopted while carrying out the activity. As evident from Table 3, most of the work postures adopted during ragi threshing involve sustained bending in association with repetitive movements. Therefore, biomechanically such work is highly detrimental with possible lead towards spinal cord and other MSD related injuries. In Phase I, while beating the panicles, the knees were found bent with bent back and abducted wrist. The risk level for this subtask was found to be very high indicating that there is urgent and immediate need to find

Table 3: Analysis of working posture with REBA method during finger millet threshing

Activity Threshing	Photograph	Posture adopted	REBA score	Risk level	Action Category
Phase I: Beating panicles with wooden log		Bent back, both knees bent, both arms below shoulder level, repetitive motions, wrist abducted.	11	Very High	Necessary urgent-Work must cease until a safer solution can be found.
Phase II: Collecting ragi grains with broom		Bent back, arms below shoulder level.	4	Low	Investigate further.
Phase III: Sieving of grains		Squatting, repetitive movements of hands.	6	Medium	Further consideration should be given as to how risk can be lowered.

out a safer solution to replace this activity. Further, the ragi grains are sieved for separating chaff and grains. This activity also requires sitting in squatting posture and repetitive movements of hand. This activity fell under medium risk and requiresfurther consideration to lower the MSD risk involved. The third sub-activity of sieving grains fell under Medium risk category as the worker needs to squat for a longer period accompanied with repetitive movements of hand.

As evident from Table 3, most of the work postures adopted during ragi threshing involve sustained bending in association with repetitive movements. Therefore, biomechanically such work is highly detrimental with possible lead towards spinal cord and other MSD related injuries. Impact of these MSD related injuries were confirmed by the workers.Many work tasks and cycles are repetitive in nature, and are frequently controlled by hourly or daily production targets and work processes. High task repetition, when combined with other risks factors such as high force and/or awkward postures, can contribute to the formation of MSD. REBA analysis was carried out for 15 subjects performing the threshing activity. The mean scores for overall final REBA mean score was found as 11.06 for existing working condition (Figure 1).

On comparing the score in the REBA score sheet (Table 4), it was found that there was very high risk in the working postures of the worker. Immediately change shall be brought to discontinue the in posture. Thus, change in posture soon is recommended. Majority of the women (93.33%) were observed to be in REBA action level four (AL4) which indicates high postural risk for women performing the activity in the conventionally (Figure 1). Khan and Siddique (2005) also concluded that the workers, who have to work for long hours in a particular posture should be advised to take couple of minutes rest after working for some time to reduce pressure on the spinal column.

Table 4: REBA score and associated risk level

REBA score	Action level
1	Negligible risk
2-3	Low risk change may be needed
4-7	Medium risk, further investigation, change soon
8-10	High risk, investigate and implement change
11+	Very high risk, implements change

Source: McAtamney and Higett (1995)

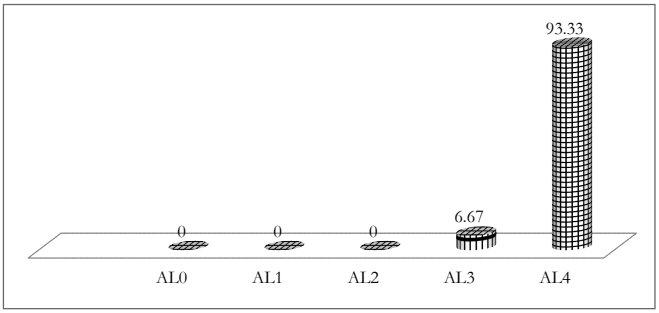

Figure 1: Risk level involved

CONCLUSION

Women manually beat the dried spikelet in scorching sun on earthen ground with big wooden logs. The repetitive nature of work with bent postures makes the activity more tedious and drudgery prone. Moreover, the work environment during threshing and winnowing is full of husk and dust particles which again is hazardous and may make women prone to respiratory problems. No usage of personal protective equipment was found. The production of small millet is higher in tribal upland areas of Koraput district therefore the post-harvest processing of these millets need to be advent with mechanization so that the time consumption, excessive physiological demand of energy and fatigue level can be minimized with reference to drudgery reduction. During various finger millet post production operations, women are suffered with high physical strain and fatigue. The repetitive nature of work with bent postures makes the activity more tedious and drudgery prone. The cardiac strain experienced in finger millet threshing labels the activity as heavy one to perform and drudgery prone. Need for technological and educational interventions like introducing low cost, labour saving drudgery reducing technology for post-harvest operations of finger millet *viz*. Ragi thresher and personal protective equipment (PPE) is emphasized.

1. The need of introducing labour saving drudgery reducing technology for post-harvest operations of finger millet *viz*. Ragi thresher and personal protective equipment (PPE) is emphasized to make these operations easier.
2. Add a short rest break to their work schedule during threshing to avoid excessive physical stress.
3. Repetition of work which causes musculoskeletal disorders should be avoided. Brief intra-work pauses to decrease fatigue in repetitive work in which the muscles can rest after expe-riencing a static load and a break after a period of continuous work.
3. Proper knowledge and education should be provided to the farmwomen for their better health and in-turn increased efficiency in the agricultural operations.

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