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Conditions and Consequences of Involvement of Farm-women in Agriculture and Off-farm Activities in Mountain Region of Uttarakhand

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Abstract

Women in North Western Himalayan hilly regions carry out most of the agricultural and off-farm activities and are therefore subjected to extra harsh conditions of work that leads to both physical and psychological stress. The work amenities are poor of essential facilities, static postures, dependence on muscular force and strength that make the work too much laborious. Women getting subjected to such work load everyday results in various kinds of disorders and health hazards in them.

Considering therefore, the importance of the role played by the women in agriculture, this study was conducted to examine the drudgery involve in farm operations in hill agricultural system. Various field operations were evaluated for analysis of drudgery prone activities. A total of 50 farm women (in the age group of 30-35 years) with random sampling technique were taken for data collection. Data on weeding, fodder cutting and harvesting operations were collected with the help of structured interview schedule. The activities were carried out with 3 replications and time bound for 30 min without rest break for analysis of various research parameters. Human Physical Drudgery Index (HPDI) was calculated for finger millet threshing activity. Results of the investigation show the perceived exertion after agricultural activities ranged from 3.77 to 5.8 on the basis of verbal expression of fatigue and moderate to severe pain in all body parts reported by farm women and also demanded the angle of deviation of normal spinal curve by the activity which are the high risk factor for muscular stresses. HPDI reduced with Millet thresher as compared to manual beating with significant reduction of drudgery with the introduction of mechanized VL millet thresher. The percent increase in heart rate by manual beating of finger millet was 8.78 which were reduced upto 3.64 with Vivek millet thresher cum pearler. The Total Cardiac Cost of Work (TCCW) and Physiological Cost of Work (PCW) were also reduced from 2017.5 to 1517.1 and 134.5 to 101.14 respectively from millet thresher. Millet thresher was developed with optimal design parameters and found ergonomically suitable for reduction of drudgery by reducing physiological ergonomic parameters as TCCW (Total Cardiac Cost of Work), CCW (Cardiac Cost of Work), EER (Energy Expenditure Rate), HR (Heart Rate), Pulse Rate and Blood Lactate Concentrations.

Keywords: Women; Farm operations; Drudgery; HPDI; Psychological stresses; Postures

Introduction

Agriculture in North-Western Himalayas is not only the mainstay of its economy but also a way of life. Both men and women play an important role in feeding the world. According to an estimate, women produce more than 50% of the total world food [1]. Women's contribution in agricultural labour force in developed countries is 36.7% while, it is about 43.6% in developing countries [2]. Report of World bank shows that Women contribute 75% in South Asia, 72% in East Asia and pacific and 75% in Sub Saharan to the labour force in Agriculture [3]. Most of the agricultural activities are incomplete without the assistance of women. But, unfortunately, their work never has been paid. Since most of this unpaid work, however it is often overlooked in official accounts.

Farmers of hills face the constraints of difficult accessibility, small and fragmented land holdings, poor and shallow soils, erratic rainfall, damage caused by the wild animals, inadequate market infrastructure, meager input availability and poor dissemination of the knowledge, that's why agriculture in hills has been a challengeable task.

Uttarakhand state is 27th state of Indian Union carved out of Uttar Pradesh. It comprises of 13 districts out of which 11 are of hill ecosystem. Uttaranchal with total geographical area of 51,125 square Km lies between 29˚44'-3˚ 25' N latitude and 77˚ 45'- 81˚ 1' E longitude. The region presents a unique geographical area where altitude ranges from 200-7,800 meter above mean sea level (msl) and therefore, the climate varies from subtropical to temperate. The Himalayan region is characterized by small and fragmented land holdings, rain-fed subsistence agriculture, low input-low output production system, sparse population, undulating terrain, poor means of transport and communication, women centered agriculture, out migration of males in search of off farm employment, poor productivity of crops and livestock, fragile eco-system, low risk bearing capacity of farmers yet rich in plant and animal diversity etc. With the application of local wisdom the hill people have been able to maintain the hill ecology in spite of all those above mentioned constraints. Hill women play a significant role in domestic and socio-economic life of the society. The development of North-Western Himalayas is not possible without developing this important and substantial segment of our society. Their daily routine starts with cock-a-doodle-doo of cockerel to mid night [4].

The nature and extent of women's involvement in agriculture, no doubt, varies greatly from region to region. Despite their importance

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to agricultural production, women face severe handicaps. They are in fact, great sufferer of occupational health hazards and biomechanical pains due to long hours of agricultural work [5,6]. From physiological point of view, the workload refers to the demands placed on the cardio respiratory system and is determined from the energy cost and cardiac cost of work [7]. Women do many of the most difficult farm tasks in India such as transplanting, weeding, harvesting, and post-harvest processing of produce. All of these tasks are time-consuming and full of drudgery.

Cereals, millets, pulses, oilseed and a number of vegetable and horticultural crops are grown hills. However, these crops are grown in different parts of the country. Millets form an important component of the traditional cropping systems and contribute significantly to the regional food and nutritional security and diversity in the national food basket; they are important in areas of their production as dry land crops, as well as for hill agriculture. As the production of small millet is higher in Uttarakhand hills, 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.

Finger millet and barnyard millet are important pseudo-cereal crops of the hills. Threshing of these crops is done manually which is a lengthy and tedious process and causes severe drudgery to the farmer.

Drudgery of farm women is an important aspect that has attracted wide attention of researchers. If measured by the extensiveness and intensiveness of their involvement, farm women shoulder much more burden than men. Importantly, women are involved in more strenuous activities as compared to men. Studies on agricultural operations show an increasing involvement of women in crop production [8]. Many of such activities are drudgery prone to varying degree. Even women suffer from different health problems which adversely affect their working efficiency and family welfare. Women have shorter time to rest than men and environmental degradation is increasing women's workload [9]. Several researchers have studied and confirmed that women work for 14-18 hours daily [10,11] on livestock raising, fetching of fodder, farming operations, collecting fuel and water from far off places and expend more total energy a day as compared to men. Unfortunately, data on the extent to which women are affected in the working environment and the effect on their work output are not available. Considering the multiple roles of agricultural women, the present study is an attempt to explore the drudgery involved in farm operations, which are studied with certain specific objectives:

- To study the medical profile of hill women respondents selected for assessment of drudgery-prone activities.
- To assess the psychological parameters while performing farm activities.
- To evaluate the perceived muscular stresses of the women performing farm operations.
- To assess Human Physical Drudgery Index (HPDI) of Finger Millet threshing activity.

Methodology

Various field operations were evaluated for analysis of drudgery prone activities. A total of 50 farm women (in the age group of 30-35 years) with random sampling technique were taken for data collection. Data on weeding, fodder cutting and harvesting operations were collected with the help of structured interview schedule. The activities were carried out with 3 replications and time bound for 30 minutes without rest break for analysis of various research parameters. Borg General Scale (1982) was used for assessing the perceived exertion (RPE) of subjects while performing various activities [12]. Biomechanical stresses during performance of activities were measured by recording the incidence of body pain experienced by hill women in different body parts by administering body map (developed by Corlette and Bishop [13]. Pains in different body parts due to faulty work practices were measured with the help of a suitable body map. In order to ascertain the degree of severity of pain, a five point scale given by Verghese et al. for women was used [14].

Human physical drudgery index (HPDI) of finger millet threshing activity

Human Physical Drudgery index can be calculated based on linear combination method using the scores obtained from Time spend on the activity, task performance score, difficulty score of the activity, body posture adopted, frequency of postural change, load/force and postural discomfort.

- **Step I**- Time spent (hrs/year) = time in hr/day × total no of days performed in a year
- **Step II- Task performance score**

Daily- 5, Alternate days-4, Weekly-3, Fortnightly-2 and seasonally-1

- **Step III- Difficulty score of activity**

Most difficult-5, difficult-4, neutral- 3, easy-2 and very easy-1

- **Step IV- Body posture adopted**

Upright-1, trunk flexion/extension 0-20˚-2, trunk flexion 20-60˚/ extension>20˚-3, trunk flexion >60˚-4 (Additional scores if back twisted +1, squatting/stooping +1, one or more body parts are static for longer than 1 min +1, repetition of activity +1)

- **Step V- Frequency of Postural change (no of times posture changes)**

1-3 times- 1, 4-6 times- 2, 7-9 times-3 and >9 times

- **Step VI- Postural discomfort (pain/numbness/tingling in body parts)**

Very severe-5, Severe- 4, Moderate-3, Light-2 and Very Light-1

- **Step VII- Load/force**

0-5 kg-score 1, 5-10 kg-score 2, 10-15 kg-score 3, 15-20 kg score-4, >20 kg-5

Formula for calculating HPDI

HPDI (Human Physical Drudgery Index) = (Ai+Bi……+Gi)/7 *100

Results and Discussion

Medical profile of women in hill region of north-west himalayas

To make the evaluation of the agricultural women purposeful, the sample profile covering the demographic data of women, Physiological parameters (Table 1) in which medical history were considered. Data in Figure 1 shows the medical profile of selected women agricultural

Physiological Characteristics	Mean	Std. Deviation
Age, Years	23.5	2.31
Weight, Kg	48.5	3.19
Height, cm	152.5	3.1
HR rest, beats/min (3 replication)	75.73	2.19
HR max, beats/ min (3 replication)	116.10	3.54
Mean Blood Pressure (3 replication)	83.44	2.15
Pulse Rate (per min)	72.94	1.98
BMI, kg/m^2	20.98	3.51
Blood Lactate Accumulation	2.46	1.58

Table 1: Physiological Characteristics of the Subject.

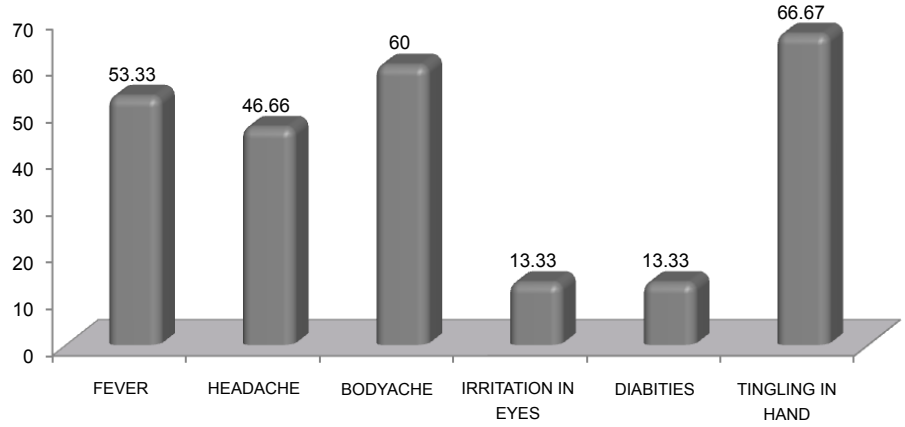

Figure 1: Medical profile of women during last one year.

Activities	Mean RPE	Interpretation
Weeding	4.1	Somewhat strong
Fodder Cutting	5.73	Very Strong
Harvesting	4.92	Strong

Table 2: Rate of Perceived Exertion (RPE) during agricultural operations N=50 R=3.

workers during last one year. It was found that about 53 per cent of respondents suffered from fever which was reported temporary in nature Occurrence of headache, body ache, and irritation in eyes were also reported by commendable proportion (46.66 per cent, 60 per cent and 13.33 per cent) of respondents. Chronic illnesses as diabetes mellitus as well as occupation induced illnesses like tingling in hand were also reported by respondents in last one year.

Fatigue analysis during agricultural activities

To study the effect of various agricultural activities on the subject's perception of exertion they were asked to give ratings on a 10 point scale after completion of task. Table 2, envisaged the mean exertion perceived by women workers. It was found that the mean rating of perceived exertion ranged from 3.77 to 5.8 on the basis of verbal expression of fatigue.

Work Related Muscular Stresses perceived by respondents

The problems pertaining to illness, injuries and disorders related to muscular stress in the neck, shoulder, arms and hands are well recognized [15-17]. A cursory glance into Figure 2 revealed that in the weeding activity moderate to severe pain in all body parts was reported by farm women. However in the ankle region maximum pain (severe) was reported due to adoption of unnatural posture (squatting). Elisjistom and Nachemson [18] also found that unnatural postures lead to several musculoskeletal problems. There are certain risk factors like awkward posture, force, repetitive activities and inadequate rest [19]. Further Aaras and West Gaurd; Keyserling et al.; Ryan and Burdorf et al. supported the above said facts by stating that poor body posture was the major cause of musculoskeletal disorders [20-23]. Further during fodder cutting activity moderate pain was perceived by women in shoulder, upper back, lower back and knee region and mild pain in neck and ankle region. During harvesting activity severe pain in shoulder and lower back was reported by the women. In line with the fact documented by Miranda et al. [24] women are reporting high perceived pain in various body alignments including low muscle mass and low bone mineral density.

Human physical drudgery index (HPDI) of finger millet threshing activity

In hills, the processing of small millets is mainly done by women. The drudgery involved in manual processing of small millets is an important reason of reduction in consumption of small millets. The small seed size also makes processing of these crops difficult and time consuming. Development of disease resistant high yielding varieties with suitable production technology and good processing machines suited to small millet farmers are helpful in reducing the drudgery of farmers. To overcome this problem, an efficient finger millet and barnyard millet thresher named as Vivek *Mandua* / Madira Thresher

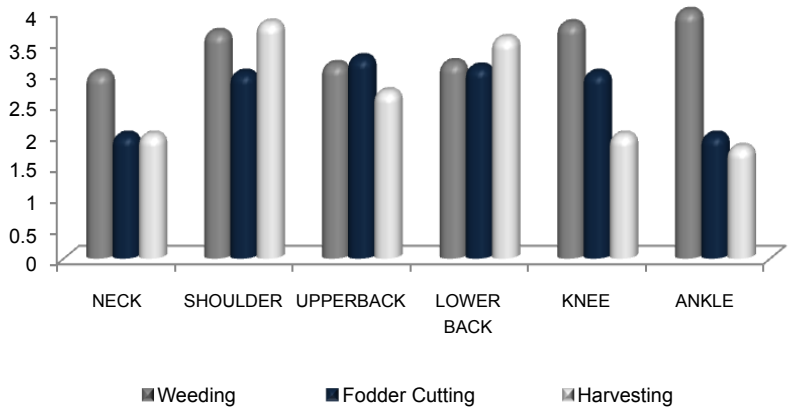

Figure 2: Work Related Muscular Stresses perceived by respondents.

Activity	Mode of Operation	HPDI	Z-test
Finger millet Threshing	Manual Beating	84.9	13.803*
	With Millet Thresher	48.7	

Two-tailed p-value<0.0001, 99% confidence intervals, * Significant at 1% level of significance

Table 3: Human Physical Drudgery Index (HPDI) of finger millet threshing operation.

Parameters	Finger millet (Mandua) Threshing activity		Z value
	Traditional method	With millet thresher	
HR work, beats/min	127.8	97.5	13.9236*
$HR_{recovery,}$ beats/min	82.5	74.56	10.5564*
Percent increase in Heart Rate (Recovery Period)	8.78	3.64	5.4009*
TCCW	2017.5	1517.1	97.6495*
PCW	134.5	101.14	11.5545*
$EER\ (KJ/min)_{work}$	11.60	6.78	7.4382*
$EER\ (KJ/min)_{recovery}$	4.39	3.1	5.4913*
Percent increase in EER (Recovery Period)	31.43	14.39	34.0115*
Mean BP_{work} (mmHg)	98.52	78.64	39.680*
Pulse $Rate_{work}$ (per min)	96.58	78.20	27.3202*
Percent increase BP	14.23	8.70	10.5933*
Percent increase Pulse rate	40.86	16.78	18.8115*
Blood lactate concentration $(mmol/l)_{work}$	7.94	2.94	13.8037*

All statistical analyses were carried out with SAS software platform SAS version 9.2, 2008, Two-tailed p-value<0.0001, 99% confidence intervals, * Significant at 1% level of significance

Table 4: Ergonomic evaluation of Finger millet threshing activity.

has successfully been designed and developed at VPKAS, Almora. This machine can thresh as well as pearl grains of finger millet, barnyard millet, proso millet and foxtail millet. Threshing and pearling of finger millet are done simultaneously, whereas in case of foxtail millet, barnyard millet, and proso millet, threshing and pearling are done separately. In order to mechanize the processing of small millets, the machine works well with >98% threshing efficiency and >90% pearling efficiency. The machine has threshing capacity of 60-80 kg and pearling capacity of 80-100 kg grains of finger millet in one hour. The machine has similar threshing capacity for barnyard millet with dehusking capacity of 2.5-4.0 kg grains per hour. Two models of these machines, electric thresher and engine operated thresher are available. These machines significantly reduce the work load and time for post harvest processing of small millets. This thresher has been well received by the cultivators as well as the development agencies.

Data pertaining to HPDI is depicted in Table 3. Human Physical Drudgery Index (HPDI) reduced with Millet thresher as compared to manual beating with significant reduction of drudgery with VL millet thresher.

Physiological ergonomic evaluation of finger millet threshing activity

Data regarding madua (finger millet) threshing activity was also evaluated on the basis of ergonomic parameters (Table 4) and it was found that the percent increase in heart rate by manual beating of finger was 8.78 which were reduced upto 3.64 with Vivek millet thresher cum perler. The Total Cardiac Cost of Work (TCCW) and Physiological Cost of Work (PCW) were also reduced from 2017.5 to 1517.1 and 134.5 to 101.14 respectively from millet thresher. Data for various other physiological parameters such as Percent increases in EER (Energy Expenditure Rate) from 31.43-14.39, Blood pressure (14.23to 8.70) and Pulse Rate 40.86 to 16.78 were also reduced with millet thresher. Blood lactate concentrations (after activity) were also reduced with 14.7-7.94 mmol/l of blood with millet thresher.

Conclusion

Women are considered as the backbone of hill agriculture and agriculture is regarded as the largest sector of the region's economy. Women in hills perform various activities to earn livelihood for the family. Agriculture is considered as the biggest unorganized sector where large number of hill women takes part actively. Women work longer and harder than men though they are paid less. They also work on more tasks than men. In spite of their enormous contributions to farming, the women have largely remained invisible as active farmers. Most people have failed to recognize that the work and involvement of women in agriculture is enormous. The multiple roles played and the productive inputs made by women in terms of work hours contributed or equivalent income generated in the family are neither attended to nor recorded. There is greater involvement of women under various agricultural operations along with domestic work. Many agricultural operations and household activities performed by women involve a lot of physical strain, which create serious health problems in the long run. Since they are overburdened with the work both on farm and home, there is greater chance of neglecting their health. All the agricultural operations are time-consuming and full of drudgery leading to pain and discomfort in different body parts which are high risk factor for muscular stresses in women.

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