

Ergonomic Evaluation of Drudgery Associated with Women Harvesting Yam Tubers in Benue State of Nigeria

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Abstract

The drudgery associated with the use of hoe-cutlass technology on small scale farms in Benue state of Nigeriawas ergonomically investigated. A total of 130 women farmers between the ages of 17 and 42years, working under an average ambient temperature of 36⁰c, were used in the study. Energy Expenditure Rate (EER) and the Total Cardiac Cost of Work (TCCW) were used to estimate the drudgery while the Ovako Work Analysis System (OWAS) was used to analyze work postures. Results show that, 3.10 hours of the 7.50 hours spent per day were used in peripheral activities of weeding/vein clearing, gathering tubers into barns, and 4.40 hours was used in harvesting. Physiologically, the activities of weeding/vein clearing and harvesting can be rated as moderately heavy, while gathering tuber into barns is rated as light work. The pressure exerted on the lower back, hands, and legs of these farmers indicates high drudgery associated with the use of the hoe-cutlass technology, thus necessitating technological innovation of this design in response to the new Nigeria Science Technology and Innovation (STI) policy.

Key Words: Ergonomics; Evaluation; Women; Harvesting Yam

Introduction

Agriculture is the highest singular employer of labor in most countries in the developing world. Nigeria being one of such countries has about sixty seven percent (67%) of

her rural populace involved in agriculture (NPC, 2008) and seventy percent (70%) of the farmer involved in agriculture are women (Kaul and Ali, 1996; FAO, 2008). Yam (*Dioscorea rotundata*) is a root tuber crop mostly grown in West Africa and used for food. This crop is characterized by veins which twine to the right. Although yam is produced in other continents of the world, Africa leads with about seventy six percent (76%) of the total quantity (Degrass, 1993) and Nigeria is by far the world's largest producer of yams, accounting for over 70–76 percent of the world production. Nigeria produced 18.3 million tones of yam from 1.5 million hectares, representing 73.8 percent of total yam production in Africa (FAO, 2008). Yam production in Nigeria has nearly doubled since 1985, with Nigeria producing 35.017 million metric tonnes with value equivalent of US\$5.654 billion (Degrass, 1993).

In perspective, the world's second and third largest producers of yams, Côte d'Ivoire and Ghana, only produced 6.9 and 4.8 million tonnes of yams in 2008 respectively.

The production and management of operations of this high fertility-requiring tuber is laden with tedious labor input, from land clearing, the production of mounds or ridges, planting, mulching, de-mulching, a rigorous weed control, harvesting, and barn preparation (Itodo and Daudu, 2003). However, 86 % of these activities are carried out manually using either bare hands or the prevalent hoe-cutlass

technology with its associated drudgery (*Taiwo et al*, 2002; Foege, 1995), which calls for innovations for enhanced productivity.

The use of this technology on Nigerian small-scale farms results in loss of man-hour and decreased efficiency because of the unusual work posture assumed by the users which give rise to increased physiology work load and the resulting muscle-skeletal problem (Juriji, 2000). In Benue State, the harvesting of yam tubers is an exclusive activity of females and involves using one or both hands in a stooped posture, forcefully strike the mound with a hoe to erode it and expose the tuber. This activity is preceded by weeding, and vein clearing before actual harvesting begin.

There are gaps in the appraisal of effect of work posture and fatigue associated with the cardiac cost of work. There is, therefore, the need to determine the extent of drudgery associated with the use of this common technology. This paper evaluates the ergonomically drudgery associated with women using the hoe-cutlass technology in yam tuber harvesting which in turn gives rise to loss in man – hours and decrease in efficiency.

Materials and Methods

One hundred and thirty (130) women farmers from Benue State, Nigeria were used in the study. The women were within the ages of 17 and 42 years, working under an average ambient temperature of 36⁰C, between the months of October to December. The weight and height of these farmers were measured using a weighing scale and a stadiometer respectively.

The Body Mass Index (BMI) of the farmers was calculated using equation 1. The time spent weeding, clearing veins, harvesting and gathering of the harvested tubers was measured using a stop watch and the distance walked everyday while undertaking each activity was measured with a pedometer.

The drudgery associated with manual harvesting of yam tubers using the hoe-cutlass technology was investigated by determining the physiological stress of the farmers. The Energy Expenditure Rate (EER) and TCCN were used as physiological stress index. The EER was estimated using equation 2, (Konz, 1978; Saha, 1979) while the Total Cardiac Cost of Work (TCCW) was estimated from the Cardiac Cost of Work (CCW) and the Cardiac Cost of Recovery (CCR) as expressed in equation 3 (Jyotsna, 2005).The CCW was obtained from the Average Heart Rate (AHR) and duration of work from equation 4, while the CCR was obtained from equation 5.

$$Body\ mass\ index\ (BMI) = \frac{Weight(Kg)}{Height(m)} \dots \dots (1)$$

$$EE\left(\frac{Kj}{min}\right) = 0.159 * HR - 8.7 \dots (2)$$

Where EE = Energy expenditure, and
 HR = Heart Rate $TCCW = (CCW) + (CCR) \dots \dots \dots (3)$

Where,
 CCW = (AHR) x Wd..... (4)

Where
 Wd = duration of work, and
 CCR = HR_c – HR_t,(5)

where,
 HR_c = mean recovery heart rate,(bpm)
 HR_t = mean resting heart rate (bpm)

The heart rates of these farmers were measured using a polar ANX 700 heart rate monitor. The heart rates were measured before and 10 minutes after commencement of work. The PRE scale was used to study the perceived exertion of the farmers during and after each activity according to Astrand and Rodhal (1986).

This was measured on a 5-point continuum of light, moderate, heavy, very heavy, and extremely heavy work. The work posture of the farmers were analyzed using OWAS to determine the level of exertion on the lower back, legs and hands while harvesting.

Results and Discussion

Physical Characteristics of the Female Farmers

The physical characteristics of female farmers engaged in the study are shown in Table 1. These subjects had a mean age of 28.9 years, body mass of 69 kg, height of 163.8 cm and a body mass index of 18.58%. Jyotsna et al (2005) had subjects with a mean age of 33.95 years, height of 159.0 cm, body mass of 47.8 Kg, and a body mass index of 19.15%.

Table 1: Physical characteristic of female farmers

Characteristics	Means	Std Dev	Variance
Age	28.9	8.0	63.4
Weight	69.0	11.1	124.1
Height	163.8	8.1	66.3
No of hours at work	7.2	1.6	2.5
Ambient temperature	36.3	0.4	0.2
BMI	18.58	0.005	0.3

Singh et al (1989) had subjects which had a mean age of 32 years, 158.0 cm tall, body mass of 50 Kg, and a body mass index of 19.15%. The subjects in this study are younger, taller, weighed more, but with lower body mass index than those in the studies by Jyotsna et al (2005), and Singh et al (1989). When this compared with the result of Yusuf et al (2005), in which he established that individual with body mass index range of 15.0 to 20.0 are healthy, it can be concluded that the female farmer used in this study are healthy.

Time and Activity Profile

The time and activity profile of female farmers is shown in Table 2 and they worked a mean of 7.5 hours per day, under an ambient temperature of 36°C harvesting yam tubers. 3.10 hours of the period was spent in pre harvest activities of weeding, vein clearing, and gathering tubers into barns. Subject in this process walked a mean distance of 2.13km, taking a mean of 2345 steps. Averagely female farmers spent 42 hours (5.6 working days) harvesting a space measuring 120 mounds per roll by 20 rolls.

Comparing the time and activity profile of the yam harvesters and the wheat harvester of Jyotana et al, (2005) the wheat harvesters both worked and walked longer distances and duration than the farmers harvesting yam.

Table 2: Time and Activity Profile of Women Harvesting Yam Tuber in a Single Day

Activity	Age group	Total
Implement used for pre-harvesting yam tubers	Traditional Hoe (Abya)	Traditional Hoe (Abya)
Mean time spent weeding and vein clearing per day (hrs)	2.2	2.2
Mean distance walked per day (km)	1.2	1.2
Mean time spent per day (hrs)	3.5	3.5
Mean distance walked per day (km)	1.2	1.2
Implement for post-harvesting gathering yam tubers	trays	trays
Mean time spent gathering tuber to barns per day (hrs)	1.5	1.5
Mean distance walked per day (km)	0.5	0.5

Physiological Stress

The physical stresses of the female farmers harvesting yam tubers were based on

parameters such as the heart rate, energy expenditure, physiological cost of work and Perceived Exertion Rate (PER) while performing the activity (Jyotsna et al, 2005).

Table 3 shows the average working heart rate per minute of the farmers, energy expended in each activity per minute, and the classification of workload in accordance with Astrand and Rodhal (1986).

Table 3: Mean Heart Rate, Energy Expenditure, Classification of Workload of Subjects Harvesting Yam Tuber

Activity	Working Heart rate beats/min	Energy expenditure kJ/min	Classification of workload
Weeding/vein clearing	145	14.33	VHW
Harvesting	134	12.58	VHW
Gathering tuber to barns	102	7.50	MW

VHW: Very heavy work; MW: Light work

Table 4 showed that, the activities of weeding/vein clearing cost mean heart rate of 145bpm, energy expenditure rate of 14.33kJ/min, and harvesting costs a heart rate of 134bpm, energy expenditure rate of 12.58kJ/min.

Table 4: Physiological parameter (Cardiac cost, Cardiac cost of recovery, and Rate of perceived exertion) of Subjects

Activity	Weeding/vein clearing heart beats	Harvesting beats/min	Gathering tubers Into barns
Cardiac Cost of Work (CCW)	19,140	28,140	9,180
Cardiac Cost of Recovery (CCR)	75	64	32
Rate of	4	4	3

perceived exertion			
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The activities of weeding, vein clearing and harvesting are classified as very heavy work, while gathering of the tubers into barns cost a mean of 102 bpm, 7.50kJ/min. This can be classified moderate work. The heart rates of the yam harvesters are higher than those of wheat harvesters reported by Jyotsna et al (2005) and those reported by Sharma Deepa et al (2002) respectively.

Ovako Work Analysis System

Fig 1 is the Ovako work analysis system (OWAS) Wilson et al (2005) of the effort exerted on the lower back, hands, and legs of the female farmers. The figure shows that, 11%(50min) of the 7.5 man hours was spent on the farm standing straight, 76 % (5.42min) of the 7.5 man hours spent in the stooping posture, the remaining 3% (14min), and 10% (46min) was shared by twisting and bending and twisting simultaneously.

The exertion on the hands, 13% (59min) of the time the exertion was on both hands above shoulder level, 83.60%(6.40min) the exertion was on the right hand above shoulder level, 3.60% or 17min the exertion was on both hands.

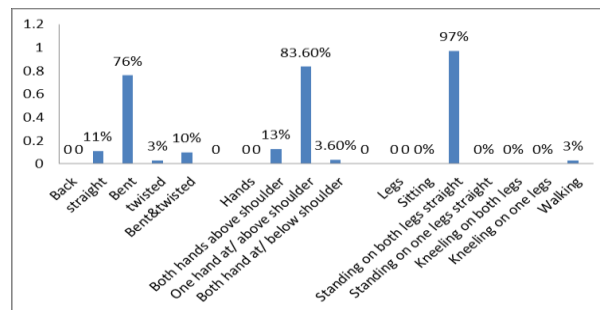


Figure 1: Exertion on the lower back, hands, and legs of females harvesting yam

The exertion on the legs showed that 97% (7.17min) was exerted standing on both legs, 3%(13min) was exerted on one leg, while 0%,

(0min) on sitting, standing on one leg, kneeling on both legs, and kneeling on one knee. The finding in this work completely agrees with what was reported by Suma et al (2004).

Conclusion

The drudgery associated with the harvesting of yam tubers in Benue State of Nigeria is very high. The sub activities of weeding/vein clearing and harvesting were rated as very heavy, while gathering the tubers into barns was rated as moderately heavy, the energy expended by the worker was much.

All the farmers investigated in the study used the local hand hoe called “abya in Tiv language “ and spent more than 75% of the work duration in the stooping position, thereby putting a lot of pressure on their lower back, and legs, while the hands experienced repetitive work strain.

This paper also concluded that if the effort to enhancing agricultural productivity as enshrined in the Nigeria new Science Technology and Innovation (STI) policy through cultivation of improved crop varieties and encouraging technology uptake and diffusion of agricultural innovations to farmers is to be a reality, the country must encourage labor-saving and low-cost gender sensitive agricultural raw materials processing technologies.

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