©Kamla-Raj 2003
PRINT: ISSN 0970-9274 ONLINE: 2456-6608
J. Hum. Ecol., 14(1): 51-55 (2003)
DOI: 10.31901/24566608.2003/14.01.07

Energy Balance of Farm Labourers

Monica Dungarwal and Maya Choudhry

INTRODUCTION

Agriculture is the back bone of Indian economy, contributing nearly 32 per cent to the national production and generating employment for 70 per cent of the population. Energy balance of an average Indian agriculture labourer is generally negative. It is not necessary that negative energy balance is always due to low intake but it may also be due to more expenditure of energy with the increase in the quantum of physical work. Good health and nutritional status of agricultural work force enhances agricultural productivity, but their poor health and nutritional status are likely to decrease it. The assessment of the effect of health and nutrition on agricultural development is not an easy task (Hussain, 1987). FAO/WHO/UNU Expert Committee (1985) has proposed assessing energy requirement on the basis of energy expenditure rather than on energy intake data. In view of the above facts and due to non-availability of energy cost values of different farm operations and limited studies on energy balance, the present study seems to be most warranted.

METHODOLOGY

Selection of Sample

The study was conducted on 50 farm labourers of Agriculture Research Sub Station (ARSS), Sumerpur, Rajasthan Agricultural University, Bikaner. The study area falls under agroclimatic zone II-B, spread over in the area of 3 million hectares. The rainfall in this zone ranges between 300-500 mm per year. The data was collected in the last 3 weeks of May and first week of June 1999 i.e. during summer season.

Anthropometric Measurements

1. *Weight: A* plateform spring balance was used for measuring weight. The measurement were observed to the nearest of 0.25 kg. The balance was caliberated and adjusted to zero everytime to avoid error.
2. *Height:* Height was simultaneously recorded using a verticle anthropometric rod. The weight and height observed were then compared with NCHS (1977) 50th percentile value for 18 years boy. The weight taken was also compared with ICMR values for reference man (1990).
3. *Body Mass Index (BMI):* This index was calculated by dividing the absolute weight (kg) with absolute height (m) squared i.e. BMI = wt/ht^2 (kg/m^2). The value obtained was interpreted as per the classes of BMI with their presumptive diagnosis suggested by James et al. (1988) and recommended by NIN (1991).

Energy Intake

A dietary survey by 24 hours recall method was conducted for 3 consecutive days using a standardised cup set to find out the food intake. The mean energy intake was computed from Food composition tables (Gopalan et al., 1989) and compared with RDA suggested by ICMR (1990).

Energy Output and Activity Record

Time spent on different activities was noted using a recall method by recording time on different activities performed on the days of dietary survey including waking and sleeping time. Energy cost values of different activities were measured by using an accelerometer known as 'CALTRAC' on 30 labourers selected randomly.

Caltrac is a personal activity computer. It is a pocket sized system easy to use in field studies. It calculates calorie expenditure based on resting metabolic rate. Age, sex, weight and height of individual subject were entered in caltrac and was placed at waist level below armpit for each subject. When an individual performs an activity, it accelerates and calculates the energy expenditure. The bending of accelerometer is directly proportional to the intensity of motion as well as to the rate of calorie burning. Energy cost values of different activities performed were determined on 30 labourers. Each activity was performed for 15 minutes to find out its energy cost which was then expressed per minute. Energy expenditure on each activity was calculated by multiplying the time spent on an activity with energy cost value obtained as follows:

Energy expenditure= Energy cost value (on an activity (Kcal) x Time spent (per minute)

Energy expenditure for each and every activity of the day was added to calculate the total energy expenditure of the day. Energy balance was calculated by subtracting energy expenditure from intake.

RESULTS AND DISCUSSION

Background Information

A total of 50 Hindu male labourers belonging to lower or lower middle class were studied. All the subjects were 20-39 years of age and working at ARSS, Sumerpur. The educational status of farm labourers was poor as 44 per cent of them were illiterate. The per capita income of the families was Rs. 544 per month. None of the subject was suffering from any chronic disease at the time of survey but habit of smoking (48 %) and drinking alcohol (54 %) was common among the labourers. Labourers spent 10 months in a year and on an average 27 days and 20 days in a month during the peak and slack seasons on farming respectively. They were working on an average for about 7 to 8 hours per day on farm and were having 12 years of experience as a farm labourer. They performed different types of farm operations in a day as assigned to them.

Anthropometric Measurements

Mean weight of farm labourers was 47.6 kg which is 79.3 per cent of the weight suggested for a reference Indian man and 68.7 per cent of NCHS 50th percentile given for 18 years old boys. Mean height of the farm labourers was 162 cm. When compared with height of 18 year old boys NCHS 50th percentile, it was 97.8 per cent revealing that mean height of man studied was normal. Mean BMI of these labourers was 17.6 revealing that on an average weight of these farm labourers was low for their height.

BMI indicated that 88 per cent of the farm labourers were suffering from various grades of chronic energy deficiency. About half of them were mildly chronic energy deficient and remaining half were low weight normal or moderate to severly chronic energy deficient.

Energy Intake

The mean daily energy intake was 2085 kcal. The energy intake was 72.6 per cent of the respective Indian recommendation. The average intake of the farm labourers per kg of body weight was also low i.e. 44 kcal/kg in comparison to 48 kcal/kg for a moderate worker, calculated by dividing RDA of 2875 kcal by the weight for a reference man (ICMR, 1990).

Table 1: Energy cost values of farm and personal activities by caltrac accelerometer

S. No.	*Activity*	*Energy expenditure/15min.*
1.	Irrigation	25.2
2.	Hoeing	44.9
3.	Weeding	25.5
4.	Urea broad casting	38.9
5.	Threshing	23.8
6.	Winnowing	25.7
7.	Harvesting	27.3
8.	Plucking of fruits	25.8
9.	Removal of seeds from fruit	21.6
10.	Washing of fruits	23.1
11.	Bunding	51.3
12.	Feeding animal	25.8
13.	Sitting quietly, sitting and praying/watching TV/listening Radio	17.7
14.	Standing	19.9
15.	Walking at normal pace	59.4
16.	Cycling	91.4
17.	Sitting, eating and talking	22.7
18.	Getting ready	24.4
19.	Cooking	25.5
20.	Sleeping	16.1

Energy Expenditure

1. *Energy Cost of Various Activities:* In the present study caltrac was used to find out the energy cost of various farm and personal activities on 30 farm labourers. The energy cost of farm activities ranged from 21.6 kcal/15 minutes for removal of seeds from fruits to 51.3 Kcal/15 minutes for bunding. On personal activities energy expenditure ranged from 17.7 kcal for sitting and doing light activities to 91.4 kcal/15 minutes for cycling (Table 1).
2. *Time Spent on Various Activities*: The activities performed by the farm labourers were grouped on the basis of their energy cost values to find the time spent on different activities in a day. Among the farm operations, labourers devoted maximum time on carrying out irrigation followed by weeding, harvesting, plucking of fruits etc. Minimum time was spent on feeding animals, urea broad-

Table 2: Energy intake and expenditure by Body Mass Index

S. No.	Categories	Energy intake		Energy expenditure (Kcal)			% of Total energy expenditure of BMR
		Total (kcal)	% RDA	BMR/minute	BMR/day	Total	
1.	>16.0-17.0 (Severe/moderate)	2087±44.7 (14)	72.6	0.89±0.01	1284.8±23.49	2430±14.2	52.87
2.	17.0 - 18.5 (Mild)	2095 ± 25.3 (23)	72.9	0.93±0.04	1335.3±65.96	2456±15.0	54.35
3.	18.5 - 25.0 (Low weight normal/ normal	2063±39.5 (13)	71.7	1.00±0.05	1435.9±83.5	2505±25.1	57.32
	F values	0.23 NS	-	18.42**	20.16**	3.71*	-

Level of significance : ** $p < 0.01$; * $p < 0.05$; NS (Non-significant)
Values in parenthesis are the number of subjects

casting and bunding. This variation could be due to the type of crop cultivated and cropping time. Time spent on personal activities varied from 3 minutes in cooking to 140.9 minutes in sitting quietly.

The activity pattern of the farm labourers showed that they were moderate workers as on each working day they were spending 7.7 hours (460 min) on carrying out various farm operations which involved moderate activities.

3. *Total Energy Expenditure:* The mean total energy expenditure of a day was 2463 kcal/day by caltrac method.

Energy Intake and Expenditure in Relation to Nutritional Status: The energy intake and expenditure of farm labourers in relation to their body mass index was also calculated and is presented in table 2. The energy intake of farm labourers by categories of BMI ranged between 72 to 73 per cent of RDA showing a deficit of 27 to 28 per cent in energy intake irrespective of their nutritional status. 'F' value calculated was non-significant indicating that the current energy intake was not affecting their nutritional status.

The energy expenditure of the farm labourers for BMI categories of < 16.0-17.0, 17.0-18.5 and 18.5-25.0 was 2430, 2456, 2505 kcal/day respectively (Table 2). This shows an increasing trend in energy expenditure with the state of nutritional status. F value calculated was significant at 5 per cent level only. These results are at par with those reported by Choudhary and Jain (1997) for farm women and are justified in the following paragraph:

Nearly half of the daily energy expenditure is accounted for the basal metabolic rate. Energy expenditure on BMR of the labourers of different grades of malnutrition was calculated using FAO/WHO/UNU (1985) equation modified by ICMR (1990). The energy expenditure on BMR/min increased significantly ($p < 0.01$) with increase in the state of nutritional state. Farm labourers suffering from severe form of malnutrition had lowest BMR values, where as normal had highest values. The energy expenditure on BMR was about 57 per cent of total energy expenditure among normal subjects (Table 2), whereas it was about 53 per cent in malnourished subjects revealing that the difference in energy intake or expenditure although non-significant in labourers by grades of malnutrition was adjusted by corresponding decrease in BMR (Fig. 1).

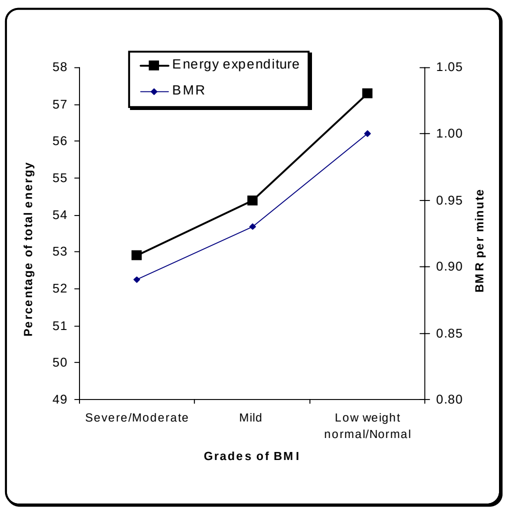

Fig. 1. Total energy expenditure and BMR in relation to nutritional status (BMI)

Energy Balance: The mean energy intake of the study group was 2085 kcal, if this intake is compared with expenditure, it shows a negative balance of 378 kcal. This result suggests that there would be a constant reduction in body weight but such situation was not observed in present study. These results are in close confirmity with the findings of Choudhry and Jain (1997), who also reported less energy intake than energy expenditure in farm women. Guzman et al. (1984) also found in male and female leguna rice farmers a low energy intake in comparison to their expenditure. Similarly, negative energy balance has been reported by Norgan et al. (1974), Bleiberg et al. (1981) and Edmundson and Edmundson (1988).

If the total energy expenditure of these farm labourer is calculated by their BMR with physical activity level (PAL) suggested by ICMR (1990), it would be 2559 kcal/day. This value is quite close to energy expenditure value of farm labourers found by caltrac. This shows that the caltrac may be used to measure energy expenditure.

Caltrac has been reported as an effective and promising method to measure energy expenditure in children, adults and old persons (Kleges et al. 1985; Kleges and Kleges, 1987; Sallis et al., 1989; Sallis et al., 1990; Gretebeck et al., 1992). The comparison between doubly labeled water method and caltrac accelerometer for measurement of energy expenditure in active older women revealed that the caltrac accelerometer appeared to be an effective method for assessing mean energy expenditure (Gretbeck et al., 1992). In adults accelerometer was highly reliable and related to oxygen consumption of 14 activities over a range of intensities. The accelerometer was more reliable and more valid than a mercury switch monitor (Montoye et al., 1983).

The correlation coefficient between energy expenditure and intake was positive and significant (r=0.56). Energy intake was found to explain only 31.1 per cent variation in energy output. Therefore, it can be said that the homeostatic mechanism which controls and regulates energy balance as described by Sukhatme and Margen (1982) involves a complex and long term lag mechanism, is true for the labourers of the present study also.

The findings of the study implies that the energy intake be increased by increasing the intake of energy rich foods such as sugar, fats and oil. Energy expenditure should also be reduced by using labour saving agricultural implements so that they maintain energy balance and consequently the nutritional status.

ACKNOWLEDGEMENT

A merit certificate was received on this paper presented in the XXXIII Annual Conference of Nutrition Society of India on 1 Dec., 2000 held at Hyderabad.

KEY WORDS Energy Intake. Energy Cost and Expenditure. Farm Labourers.

ABSTRACT The present study was conducted to find out the energy cost values of different farm and personal activities using 'caltrac' and energy balance of 50 male farm labourers of Agriculture Research Sub Station, Sumerpur, Rajasthan Agricultural University, Bikaner. An interview schedule was developed to collect information about the labourers. Food intake and activity pattern were recorded for three consecutive days by recall method. The daily activity pattern of labourers revealed that they were moderate worker. Energy cost values of farm activities ranged from 21.6 Kcal/15 minutes for removal of seeds from fruits to 51.3 Kcal/15 minutes for bunding. On personal activities energy expenditure ranged from 17.7 Kcal/15 minutes for sitting to 91.4 Kcal/15 minutes for cycling. The mean energy expenditure was 2463 Kcal/day with a mean energy intake of 2085 Kcal/day showing a negative balance of 378 Kcal/day. Energy intake and total energy expenditure was almost same among the labourers of different categories of nutritional status, while energy expenditure on BMR increased significantly with increase in the state of nutritional status by BMI. Findings suggest that labourers will be able to maintain their energy balance and consequently their nutritional status by increasing their energy intake and reducing energy expenditure by the use of labour saving agricultural implements.

REFERENCES

Bleiberg, F., Brun, T., Goihum, S. and Lippman, D.: Food intake and energy expenditure of male and female farmers from upper volta. *Br. J. Nutr.*, **(45) 3:** 505 (1981).

Choudhry, M. and Jain, S.: *Energy Balance of Farm Women in Relation to Their Nutritional Status.* Project report submitted to ICAR. Deptt. of Foods and Nutrition, College of Home Science, Udaipur (1977).

Edmundson, W.C. and Edmundson, S.A.: Food intake and work allocation of male and female farmers in an impoverished. Indian village. *Brit. J. Nutr.*, **60:** 433 (1988).

FAO/WHO/UNU: Energy and protein requirements. A report of a joint FAO/WHO/UNU expert consultation. *Techanical Report Series No. 724*, WHO, Geneva (1985).

Gopalan, C., Ramashastri, B.V. and Balasubramanium, S.C.: Revised and updated by Narsinga Rao, B.S., Deosthale, Y.G. and Pant, K.C.: *Nutritive Value of Indian Foods*, National Institute of Nutrition, ICMR, Hyderabad (1989).

Gretebeck, R., Weisel, S. and Baileau, R.: Assessment of Energy Expenditure in active older women using doubly labelled water and caltrac recordings. *Med. Sci. Sports. Exerc*. **24 (5):** Suppl.: S68 # 404 (1992).

Guzman, Cabrera, J.P., Yuchingtal, G.P., Abanto, Z.U. and Gaurano, A.K.: A study on the energy expenditure, dietary intake and pattern of daily activity among various occupational groups. *Leguna Rice Farmers, Phillipline, J. Nutr.,* **37:** 103 (1984).

Hussain, M.A.: Effect of nutriton and health on agriculture and rural development. *Food and Nutrition,* **(13)1:** 19 (1987).

ICMR: *Nutrient Requirements and Recommended Dietary allowances for Indian's:* A report of expert group of the Indian council of Medical Research, NIN, Hyderabad (1990).

James, W.P.T., Ferro - Luizzi, A. and Waterlow, J.C.: The definition of chronic energy deficiency in adults. Report of working party of the intervention dietary energy consultation group. *Eur. J. Clin. Nutr.,* **42:** 969 (1988).

Klesges, R.C., Klesges, L.M., Swenson, A.M. and Pheley, A.M.: A validation of two motion sensors in the prediction of child and adult physical activity level. *Am. J. Epidemiol.,* **122:** 400 (1985).

Klesges, L.M. and Klesges, R.L.: The assessment of children's physical activity: a comparision of methods. *Med. Sci. Sports. Exerc.,* **19:** 511 (1987).

Montoye, H.J., Washburn, R., Servais, S., Ertt, A., Webster, J. and Nagle, F.: Estimation of Energy Expenditure by portable accelerometer. *Med. Sci. Soirts, Exerc.,* **15:** 403 (1983).

NCHS.: Growth Survey for Children Birth to 18 Years. Data from the National Health Survey vital Health Statistics, 11 (165) : 28 (U.S. Department of Health Education and Welfare) (1977).

NIN. Maternal Body Mass Index and birth weight (Naidu, A.N., Neela, J. and Prahlad Rao, N.). *Nutrition News,* **12 (2):** 1 (1991).

Norgan, N., Ferro-Luzzi, A. and Durnin, J.V.G.A. Philosophical *Transactions of the Royal Society,* London B268, 309 (1974).

Sallis, J.F., Buono, M.J., Roby, J.J., Carlson, D. and Nelson, J.A. The caltrac accelerometer as a physical activity monitor for school age children. *Med. Sci. Sports Exerc.,* **22 (5):** 698 (1990).

Sallis, J.F., Buono, M.J., Roby, J.A. et al. Reliability and validity of the caltrac accelerometer as a physical activity monitor for school age children. *Med. Sci. Sports Exerc.,* **22:** S112 (1989).

Sukhatme, P.V. and Margen, S.: *American Journal of Clinical Nutrition.,* **35:** 355-365 (1982).

Authors' Address: **Monica Dungarwal** *Ph.D. Scholar* **and Maya Choudhry** *Professor and Head,* Department of Foods and Nutrition, College, of Home Science, Udaipur 313 001 Rajasthan, India

Correspondence Address: **Maya Choudhry** C-14 University Campus, Udaipur 313 001 Rajasthan, India