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Labour Energy Requirements for Farm and Non-farm Activities in Hills: A case study of paddy growers of Manipur

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ABSTRACT

The objective of the study was to work out the change in total human labour energy requirement on farm and non-farm activities during climate change. Primary data was collected from 60 randomly selected paddy growers of *Senapati* district of Manipur. Thirty-nine years (1975-2013) state level daily gridded rainfall (0.25°×0.25°) and temperature (1°×1°) data were obtained from India Meteorological Department (IMD). The study revealed that after 1994, Manipur experienced eight years of deficit monsoon rainfall. The labour requirements increased for weeding and transplanting operations during drought period. The additional burden during the drought period was comparatively more on female member of the households. The energy requirement to produce one kg of paddy was significantly higher under drought condition. The increased burden for fuel wood collection was on both male and female during droughts. The male shared the burden of fodder collection whereas, female shared the burden of fetching the drinking water. Therefore, research on developing of farm implements should be prioritized; supply of irrigation and safe drinking water should be addressed urgently by the State Government.
JEL codes: Q12, Q15, Q18, Q54

Keywords: Climate change, gender, energy requirement, agriculture

Climate change opens up many uncertainties and will demand difficult decisions. Every 1°C increase in temperature is likely to reduce the yield of some crops by 5-10% (Pachauri, 2009). Climate change was reported to hit agriculture in North Eastern (NE) region for over the years (Das *et al*., 2009; ICIMOD, 2010; Ravindranath *et al*., 2011; Ray *et al*., 2012). Climate change not only affects the environment but also economic and social development. It is therefore likely that farm activities may get affected and if the changes occur in the women oriented activities, this will directly increase the burden of the farm women. This is aggravated by the fact that farming is purely manual in the hills of NER. Women are considered to have low coping and adaptive capacity than their counterparts (UNDP, 2013). Singh (2011) reported that the difference in the distribution of resources across the gender worsens the condition of farm women and children as a result of climate change. Generally, women in the family gather wood, fodder and water; hence, shortage in supply of these as a result of climate change will add to the burden to women. The contribution of tribal women in the various economic and farm (crop as well as dairy sector) activities is well recognized (Devi, 2014; Ghosh and Ghosh, 2014; Feroze *et al*., 2015). But despite the multitude role played by women in both farm and non-farm activities, most of the policies for climate change adaptation and mitigation do not specifically address the vulnerability of women (Parikh *et al.*, 2012). Climate change generates resource shortages and unreliable job markets, which lead to the increase in male migration and women are left behind with additional agricultural and households duties which increase their hardship. The more the burden women share the more likely they will be excluded from the opportunities like education and equal participation in development. Hence, the present study was conducted in a hill district of Manipur to estimate the change in human labour energy requirements in farm and non-farm activities due to climate change and to find out who shares the burden as a result of climate change.

METHODOLOGY

Study area and sampling plan

Agricultural performance varies widely within and across the states based on the regional characteristics like resource endowment and climate (Chand *et al*., 2009). Climate in turns varies according to the altitudes. The study was conducted in Manipur state since the productivity of rice was the highest in Manipur among the NEH states. The state is located at a longitude of 93°03′ E to 94°78′ E and latitude of 23°56′ N to 25°68′ N. It experiences typical monsoon climate with variation ranging from sub-tropical to temperate conditions in hilly areas. Rice is the main food crop cultivated in both the hills and valley region of the state with an area of 1.68 lakh ha and yields of 2.2 t/ha (GoM, 2013).

Multistage sampling method was adopted in this study. Among the five hill districts of Manipur, Senapati district was selected purposively as it was identified as vulnerable to climate change (Venkateshwarlu *et al.*, 2012) and has largest area under rice among the hill districts (GoM, 2013). From Senapati district, two blocks *viz*., Kangpokpi and Saitu block were randomly selected. From each of the selected blocks, cluster of 2-3 village were selected randomly. From these villages a sample of total 60 paddy growers was drawn.

Data: Primary data from sample households was collected through well structured schedule on human labour requirement for paddy cultivation, wood and fodder collection, and fetching of drinking water. Climatic data were analyzed using the thirty-nine years (1975-2013) state level daily gridded rainfall (0.25°×0.25°) and temperature (1°×1°) data obtained from India Meteorological Department (IMD), Pune.

Drought analysis: Linear trend in monsoon rainfall was estimated using ordinary least squares (OLS) technique. Monsoon rainfall deviations were calculated by taking difference between current year monsoon rainfall and long term average (39 years). Deficit of less than 25% and more than 25% but less than 50% than average rainfall were classified as mild and moderate drought, respectively (IMD, 1971).

Energy conversion: To work out the labour energy requirement, male labour energy coefficient of 1.96 MJ/hr and female labour energy coefficient of 1.57 MJ/hr was used (Nassiri and Singh, 2008).

Human energy indices: Specific energy and energy productivity was worked out to estimate the human energy indices for paddy cultivation as paddy is the major cereal crop cultivated in the district. Specific energy indicates the amount of energy spent to produce a unit of marketable product (MJ/kg) and the following formula is as follow.

Energy productivity is the term used to estimate the yield of marketable product received per unit of energy consumed (kg/MJ) and the formula is as follow.

RESULTS AND DISCUSSION

Drought in Manipur

The amount of monsoon rainfall is very important for *kharif* rice production and the deviation from normal during this season is detrimental for optimum crop yield. The average monsoon rainfall of 989.87 mm was received in Manipur during 1975-2013 and the inter year variation was 21% (Table 1). The amount of rainfall has shown declining trend but it is insignificant. Fig. 1 depicts percentage deviation in monsoon rainfall from the long term average. Higher than normal monsoon rainfall were recorded in Manipur consecutively 3 years 1975-1977. This was followed by consecutive deficit rainfall for four years during 1978-1981. The period 1982-1994, registered a deficit monsoon rainfall in 1987, 1989 and 1992. But after 1994, eight consecutive years faced deficit rainfall out of which four years were deficit of more than 20%. The years

2004, 2007 and 2008 registered excess rainfall of more than 20%. This was again followed by a deficit of more than 20% in 2009 which was declared a drought year (Fig. 1). About 46% of the monsoon seasons encountered mild drought in Manipur and 5% were moderate year during the study period.

Table 1: Monsoon rainfall and drought in Manipur during 1975-2013

Sl. No.	Rainfall	Unit	Value
1	Average rainfall	mm	989.87
2	Minimum rainfall	mm	711.58
3	Maximum rainfall	mm	1597.72
4	CV	%	20.62
5	Linear trend coefficient (p value)	mm/year	-0.33 (0.91)
6	Frequency of mild drought year	%	46.15
7	Frequency of moderate drought year	%	5.13

Energy requirement for paddy cultivation

Land preparation consumes maximum of the total energy requirement; transplanting, weeding, harvesting and threshing were the major energy consuming activities (Table 2). The contribution of female labour in paddy cultivation was equally important alike their male counterpart as the difference was only 1.08 labour days/ha (246.10 MJ/ha). Land preparation, threshing and irrigating operations were found to be the male dominant operation whereas female were primarily engaged in transplanting, weeding and harvesting operations in the study area. Sowing, fertilizers/farm yard manure (FYM) application and spraying plant protection chemicals were the activities shared by both the genders (Table 2).

The total labour energy requirement has marginally increased during drought condition in case of both male and female labour due to increase in labour requirement in transplanting and weeding activities and this increase was comparatively higher in case of female labour. Additional energy consumption was more for weeding and the difference was higher in female than male. For land preparation, the number of human labour engaged was not changed in drought condition due to increase in machine and bullock labour hour when needed (Table 2). The timely arrival and amount of rainfall was found to be critical for paddy cultivation particularly for transplanting and weeding operations. The delay in onset of monsoon made the farm households to postpone their transplanting either a week or two. In such a situation, the labour requirement particularly that of female increased because of the low amount of standing water on the field than normal which made transplanting burdensome. The weed infestation increased during drought or low rainfall periods hence the additional labour were engaged for weeding in the crop field.

Human energy indices

Under the normal condition 0.50 MJ male and 0.40 MJ female energy was required to produce one kg of paddy which increased significantly under drought in case of both, male and female. Increase in requirement of specific energy was marginally higher in case of male labour than female labour

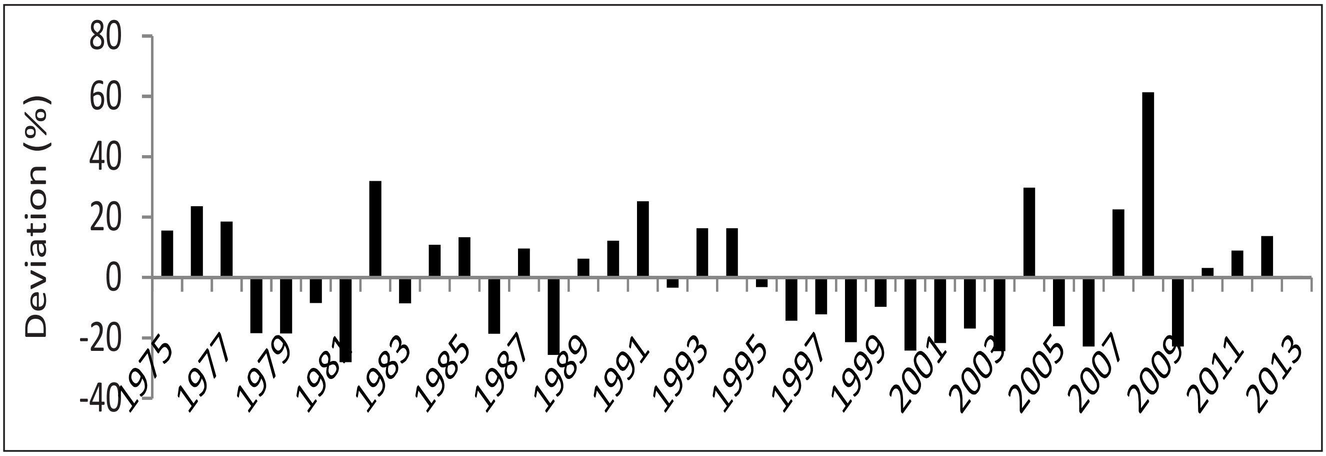

Fig. 1: Percentage deviation of monsoon rainfall from long term average during 1975-2013

Table 2: Energy use pattern in paddy cultivation during normal and drought conditions

(MJ/ha)

Operations	Energy requirement under normal condition		Energy requirement under drought condition		Mean difference		z stat (p -value)	z stat (p - value)
	Male	Female	Male	Female	Male	Female	Male	Female
Land preparation	427.63 (35.93)	129.18 (13.69)	427.63 (35.61)	129.18 (13.31)	—	—	—	—
Sowing	22.54 (1.89)	13.30 (1.41)	22.54 (1.88)	13.30 (1.37)	—	—	—	—
Transplanting	123.22 (10.35)	237.79 (25.19)	123.99 (10.32)	243.09 (25.06)	0.77	5.30	-0.00 (0.99)	-0.20 (0.84)
FYM/fertilizers application	26.36 (2.22)	18.57 (1.97)	26.36 (2.19)	18.57 (1.91)	—	—	—	—
PPC spraying	10.32 (0.87)	6.44 (0.68)	10.32 (0.86)	6.44 (0.66)	—	—	—	—
Weeding	194.76 (16.37)	290.42 (30.77)	204.96 (17.07)	311.38 (32.09)	10.20	20.96	-0.51 (0.60)	-0.78 (0.43)
Harvesting	129.30 (10.87)	159.59 (16.91)	129.30 (10.77)	159.59 (16.45)	—	—	—	—
Threshing	219.70 (18.46)	88.66 (9.39)	219.70 (18.29)	88.66 (9.12)	—	—	—	—
Irrigation	36.22 (3.04)	0.00 (0.00)	36.22 (3.02)	0.00 (0.00)	—	—	—	—
Total	**1190.05**	**943.95**	**1201.02**	**970.21**	**10.97**	**26.26**	**0.92 (-0.09)**	**0.69 (-0.39)**

Note: *Figure in the parentheses indicate percentage to the total*

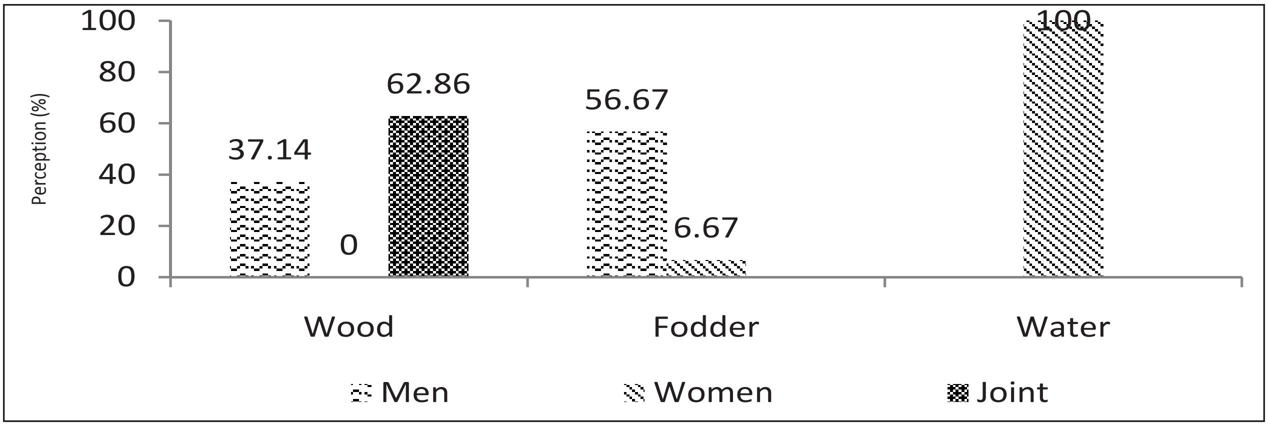

Fig. 2: Perception of the farmers about sharing of additional burden

(Table 3). The energy productivity was higher in case of female than male but it declined significantly during drought period; and the decline was higher in case of female than male. The trend of the indices manifest a detrimental effect that climate change brings on the farm labour productivity and energy consumption which increase the burden and at the same time effect the food security of the region.

Labour energy requirement for non-farm activities

Collection of fodder and firewood from the forest; and fetching water were the major non-farm activities in which the female respondents were engaged in the study area. The respondents reported that though the availability of fire wood was not yet a notable problem in the study area but availability of fire wood declined in the recent years and they had to cover extra distance for collection of the same. Moreover, some of the villagers sold firewood to supplement their farm incomes during the lean periods which increased the competition to the usual users. Per week human labour energy requirement increased by 13.39% for collection of fire wood (Table 4). Majority (62.86%) of the farmers opined that the burden was shared by both male and female of the households; whereas about 37.14% reported that the burden was on male only (Fig. 2).

Availability of fodder for the animals was found to be scanty during the drought period which increased the energy requirement substantially (Table 4). The farmer respondents opined that the

Table 3: Gender wise specific energy and energy productivity of paddy cultivation from labour during normal and drought conditions

Indices	Normal condition		Drought condition		Mean difference		z stat (p-value)	
	Male	Female	Male	Female	Male	Female	Male	Female
Specific energy (MJ/kg)	0.50	0.40	0.71	0.57	0.21**	0.17**	-2.13 (0.03)	-2.17 (0.03)
Energy productivity (kg/MJ)	2.00	2.52	1.41	1.75	0.59***	0.77***	2.96 (0.00)	2.87 (0.00)

Note: *** and *** indicates p<0.05% and p<0.01%, respectively.*

Table 4: Labour energy consumption for collection of wood, fodder and fetching water

Particular	Time (hr/wk)		Energy (MJ/wk)			
	Normal	Drought	Normal	Drought	Mean difference	z-stat
Wood	4.57	5.19	8.96	10.16	1.20 (13.39%)	-1.07 (0.28)
Fodder	20.07	26.72	39.34	52.37	13.03 (33.12%)	-1.48 (0.13)
Water	2.79	4.24	4.38	6.65	2.27*** (51.83)	-3.48 (0.005)

Note: **** indicates p<0.01*

extra burden for this was shared primarily by the men (57%). The decline in rainfall in the study area was found to reduce drinking water supply significantly. The water supply by Public Health Engineering (PHE) was reported to be irregular in terms of frequency and quantity in the recent years and the well or underground private tanks were found to remain dry during the winter season. The female members in the family travelled far in search of water which increased the energy consumption significantly (Table 4). The sample farmers reported that the burden was entirely on the women of the households.

CONCLUSION

The study was conducted to ascertain the effects of climate change on labour energy requirement in farm and non-farm activities in Senapati district of Manipur. The study revealed that the amount of monsoon rainfall has declined over the years during the study period and the deficit in monsoon rainfall was registered in eight years during the study period. The total human labour energy requirement for rice cultivation increased marginally during the drought period, particularly in case of rice transplantation and weeding activities. This has increased the burden on female farmers as the operations were performed manually in the study area. The change in specific energy and energy productivity signaled the detrimental effect of climate change on both labour energy as well as food security. The energy requirement for non-farm activities also increased during drought period. The additional burden on wood collection was shared by both male and female farmers, whereas, fetching of drinking water was the sole responsibility of the female members in the households. Overall, the total energy requirement has increased during drought period and the burden was more in case of female members of the households. Therefore, the study suggests that research may be directed towards development of gender specific farm implements and ensuring supply of irrigation and safe drinking water by the State Government.

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ANNEXURE I

Labour requirement for paddy cultivation during normal and drought conditions

(person days/ha)

Operations	Normal condition				Drought condition			
	Days		Hours		Days		Hours	
	Male	Female	Male	Female	Male	Female	Male	Female
Land preparation	27.27	10.29	218.18	82.28	27.27	10.29	218.18	82.28
Sowing	1.92	1.41	11.50	8.47	1.92	1.41	11.50	8.47
Transplanting	7.86	18.93	62.87	151.46	7.91	19.35	63.26	154.84
FYM/fertilizers application	2.24	1.97	13.45	11.83	2.24	1.97	13.45	11.83
PPC spraying	1.32	1.03	11.83	5.27	1.32	1.03	11.83	5.27
Weeding	12.42	23.12	99.37	184.98	13.07	24.79	104.57	198.33
Harvesting	8.25	12.71	65.97	101.65	8.25	12.71	65.97	101.65
Threshing	14.01	7.06	112.09	56.47	14.01	7.06	112.09	56.47
Irrigation	2.31	0.00	18.48	0.00	2.31	0.00	18.48	0.00
Total	**77.60**	**76.52**	**613.74**	**602.41**	**78.30**	**78.61**	**619.33**	**619.14**