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Comparison of agricultural mechanization parameters between Bundelkhand and Eastern region of Uttar Pradesh, India

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■ **ABSTRACT :** Agriculture is the main occupation in the Uttar Pradesh about 59.3 per cent of total workers in the state are engaged in agriculture. The Bundelkhand region is characterized as low rainfall and dry with vast marginal lands. A sizeable area (84%) was allocated to food grain crops in this region. Among cereals, wheat was the important crop. Eastern region of Uttar Pradesh is flood prone. Poverty is acute in this region. Therefore, household food security is the primary concern of the farm households in this region. Agricultural mechanization technology further varies from location to location and crop to crop. Thus, the quality of inputs of mechanization and consequently land and labour productivity may differ considerably. After selection of variables, a questionnaire was prepared to collect primary data from each agro-climatic zone of Bundelkhand region and eastern region. In Bundelkhand region primary data were collected from 100 farmers from 10 villages of 2 districts *i.e.* 50 farmers from each district. In eastern region primary data were collected from 180 farmers from 18 villages of 3 districts *i.e.* 60 farmers from each district. The mechanization index, power availability, cropping intensity, irrigation intensity, annual farmers income, annual input cost, mechanical energy, total energy were higher in western region in comparison to eastern region but human energy was more in eastern region than Bundelkhand region. The average value of mechanization index, power availability, cropping intensity, irrigation intensity, annual farmers income, annual input cost, human energy mechanical energy, total energy in Bundelkhand region and eastern region of Uttar Pradesh were 0.921, 1.61 kW/ha, 124.59 per cent, 124.59 per cent, Rs. 119852, Rs.32463, 26.63 kWh/ha, 400.31 kWh/ha and 426.94 kWh/ha, 0.951, 2.61 kW/ha, 160.42 per cent, 160.42 per cent, Rs.177125, Rs.49586, 81.98 kWh/ha, 655.49 kWh/ha and 735.94 kWh/ha, respectively. Similarly, degree of mechanization was highest in eastern region than Bundelkhand region but threshing operation and diesel pumps are more mechanized in Bundelkhand region than eastern.

■ **KEY WORDS :** Mechanization index, Farm power, Degree of mechanization, Cropping intensity, Human energy, Mechanical energy, Total energy

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Agriculture is the main occupation in the Uttar Pradesh about 59.3 per cent of total workers in the state are engaged in agriculture. But, the more important phenomenon is that the percentage share of cultivators to total workers has reduced from 41.1 per cent in 2001 to 29.0 per cent in 2011. The Bundelkhand

region is characterized as low rainfall and dry with vast marginal lands. A sizeable area (84%) was allocated to food grain crops in this region. Among cereals, wheat was the important crop. This region is lagging far behind in adoption of improved varieties and application of fertilizers. Irrigation facilities are sparse in the region. Area under HYV of wheat was only 80 per cent, which was near 100 per cent in Western, Central and Eastern regions. In this region, additional area under pulses was also brought from marginal and less fertile areas. This region due to scanty rainfall and scarcity of surface and groundwater is naturally specializing in favour of pulses and oilseed crops. Introduction of improved, high yielding and short-duration varieties of pulses and oilseed crops would go a long way in boosting their production and augmenting farm income.

The agro-climatic zone of Bundelkhand of Uttar Pradesh includes seven districts *viz.*, Jalaun, Jhansi, Chitrakoot, Lalitpur, Mahoba, Hamirpur and Banda districts. It receives about 900 mm of rainfall. The production of food grain is 14.58 q/ha and cover area 29.61 lakh hectare cultivated area. A little over 60 per cent of the area is cultivated, but compared to other parts of Uttar Pradesh; the sub-zone has less developed irrigation facilities. Only about 25 per cent of the cultivated area is irrigated as against a state average of nearly 60 per cent. Soil erosion is high and land productivity is low.

Eastern region of Uttar Pradesh is flood prone. Poverty is acute in this region. Therefore, household food security is the primary concern of the farm households in this region. To meet the household food security, as high as 91 per cent of all agricultural land was allocated to food grain crops. Rice and wheat shared about 75 per cent of the GCA. Chickpea and pigeonpea were the main pulses in the region. The Eastern Plain Zone includes Azamgarh, Mau, Balia, Faizabad, Ghazipur, Jaunpur, Chandauli, Barabanki, Sultanpur, Amethi, Sant Ravidas Nagar and Varanasi districts. The rainfall is adequate with a normal of 103 cm. The average food grain production is 23.43 q/ha. The soil of this zone is alluvial, sodic and diara soil. The cultivated area is about 32.05 lakh ha. The climate is dry sub-humid to moist sub-humid. Over 70 per cent of the land is cultivated and more than 80 per cent of the cultivated area is irrigated.

The North Eastern Plains Zone includes the districts of Baharaich, Gonda, Balrampur, Basti, Gorakhpur, Sidharth Nagar, Shravasti, Sant Kabir Nagar, Lakhimpur Kheri, Maharajgunj, Kushinagar and Deoria. The productivity of food grain is 25.17 q/ha. The type of soil of this zone is alluvial and calcareous soil. The rainfall is quite high at about 121 cm, the climate is moist sub-humid to dry sub-humid. 73 per cent of the land area is cultivated and about half of the cultivated land is irrigated. Tube wells are the major source of irrigation.

This Vindhyan Zone includes Mirzapur, Santravidas nagar, Sonbhadra districts of Uttar Pradesh. The average rainfall is adequate at about 114 cm. The productivity of food grain of this zone is 17.62 q/ha. The zone has black heavy, red granular and alluvial soil. The climate is similar to the other parts of the eastern plains of Uttar Pradesh. The irrigated area is 52.85 per cent. The type of soil is black heavy, red granular and alluvial soil. The cultivated area is 11.34 lakh ha. However, the region has a very high forest cover of about 40 per cent of the land. Less than a third of this land is cultivated and only a third of this is irrigated.

In modern era, agricultural mechanization draws a major controversy that it is considered as the application of mechanical power technology, particularly tractors. However, three main levels of mechanization technologies need consideration: human power, animal power and mechanical power technologies, with varying degrees of sophistication within each level (Rijik, 1989), on the basis of capacity to do work, costs and precision and effectiveness (Morris, 1985). Agricultural mechanization technology further varies from location to location and crop to crop. Thus, the quality of inputs of mechanization, and consequently land and labour productivity may differ considerably (Gifford and Rijik, 1980). So, mechanization planning requires the quantification of level of mechanization for each crop production. Several authors developed different methods to quantify the level of mechanization based on power or energy availability and its impact in agricultural and labour productivity.

Zangeneh *et al.* (2010) defined mechanization index (MI) and level of mechanization (LOM), to characterize farming system of potato in the Hamadan province of Iran. These indicators are defined mathematically as eq (1) and (2), respectively. The MI elaborated here is an expression of the deviation of the actual amount of motorized farm work from the normal values at the regional level.

$$MI = \frac{1}{n}\sum_{i=1}^{n}\frac{M_{e(i)}}{M_{av}} * \frac{L_i}{TL_i} \quad ....(1)$$

where,

MI = Mechanization index for the production unit 'a', $M_{e(i)}$ = Overall input energy due to machinery in the production unit 'a', M_{av} = Regional-average energy due to machinery, L_i =Land area cultivated in the production unit 'a', TL_i = Total farm land ownership of production unit 'a', n = Number of farms.

The MI index, proposed by Andrade and Jenkins (2003) is an indication of the amount of machinery a given farmer uses for farm work compared with the average in the region. The second term in eq. (1) includes a ratio between the land area cultivated with wheat crop and the total land ownership. This term was introduced because it reflects the importance of land demand for cultivation. The LOM index is based on the premise that a mechanized farmer is the one that finds a way to utilize amounts of mechanical energy that are higher than the typical values using locally available technology.

$$LOM = \sum_{i=1}^{n}\frac{P_i * \eta}{L_i} \quad ....(2)$$

where, LOM = Level of mechanization, P_i = Power of tractors, η = Correction factor for utilized power (0.75).

Field capacity was multiplied by rated power so the quantification of energy expenditure was made in work units (kWh). The regional normal will be obtained after compiling a full dataset of all respondents and then it would be defined the mode for the number of passes for each operation as well as the mode in tractor size and field capacity.

The level of mechanization is calculated by the following formula (Almasi *et al.*, 2000).

$$\text{Mechanization level (hp/ha)} = \frac{\text{Total power}}{\text{Cultivated area}} \quad ...(3)$$

The total power of existing tractors (hp) = Average nominal power of one tractor x number of working tractors.

Total real power of tractors = Total power of existing tractors x Conversion co-efficient (0.75).

Animal energy (hp-h) = Total existing animal power x Annual functional hours.

Annual functional hours = Number of functional days x Mean functional hours during a day.

Total existing animal power (hp) = Produced power of animal x Number of animals.

Human energy (hp-h) =Total exiting human power x Annual functional hours.

Annul functional hours= Number of functional days x Mean functional hours during a day.

Total existing human power (hp) = Produced power of human x Number of humans.

METHODOLOGY

After selection of variables, a questionnaire was prepared to collect primary data from each agro-climatic zone of Bundelkhand region and eastern region. The selected district from each agro-climatic zone of Bundelkhand region and eastern region were Jhansi, Chitrakoot and Varanasi from eastern plain zone, Lakhinpur Kheri from North eastern plain zone and Mirjapur from vindhyan zone eastern region of Uttar Pradesh, respectively. From Bundelkhand region two district were selected, then from each district, 5 villages and then from each villages, 10 farmers were selected using random sampling. Primary data were collected from 100 farmers from 10 villages of 2 districts *i.e.* 50 farmers from each district. A stratified multistage sampling design was applied considering district and village as strata. The villages were selected from three mentioned districts from eastern agro-climatic zones in eastern region of Uttar Pradesh using random sampling and 3 districts out of 27 districts of eastern region were taken for the study. Then from each district, 6 villages and then from each villages, 10 farmers were selected using random sampling. Primary data were collected from 180 farmers from 18 villages of 3 districts *i.e.* 60 farmers from each district. As mechanization is a multi-dimensional concept, thus, the following indices were evaluated to study the mechanization status in target region. The many variables were selected based on requirements to estimate degree of mechanization, level of mechanization (power availability), mechanization index, cropping intensity, irrigation intensity, input cost and farmers Income. The following variables were selected:

Degree of mechanization (MD):

It is one of the quantitative measure of mechanization, by which the degree of mechanization of different operations in a cropping system like land

preparation, sowing, weeding, irrigation, spraying, harvesting, threshing, transportation of agri-cultural produce and etc. can be assessed. It is the ratio of mechanization area accomplished to the area to be mechanized (Almasi *et al*., 2000). The degree of mechanization of particular implements used in a particular agricultural operation can be given as:

Degree of mechanization = Mechanized area/ Area to be mechanized. ...(4)

Level of mechanization (power availability):

Farm power is an essential input in agricultural production system to operate different types of equipment for timely field completion of agricultural works to increase productivity and maintain sustainability of farm. In this study, power availability was also evaluated for western and eastern region of Uttar Pradesh. The main sources of mobile power were human, draught animal, tractors and combines whereas the sources of stationary power were oil engines, electric motors and threshers in the Bundelkhand and eastern region. The power availability was evaluated using formula given by eq. 5.

Power availability (hp/ha) = Total power/ Net cultivated area ....(5)

where,

Total power = Total mobile power + Total stationary power

Net cultivated area = Net cultivated area of target region villages wise number of tractor, combine harvester, bullocks, agricultural workers, power tiller, diesel engines and electric pump.

■ RESULTS AND DISCUSSION

The graphical representation of variation of mechanization index, power availability, total energy, cropping intensity, irrigation intensity, human energy, degree of mechanization, annual input cost, mechanical energy and annual farmers income Bundelkhand region and eastern region of three agro climatic zones *i.e.* eastern plain zone, north eastern plain zone and vindhyan zone are shown in Fig. 1 to 16. The farm mechanization indicators and their variability among different agro-climatic zones of eastern region and Bundelkhand were studied. It can be seen that eastern region is more mechanized in terms of mechanization index, farm power availability, degree of mechanization, annual input cost, annual income, average human energy, average mechanical energy and average total energy than Bundelkhand region. The mechanization index in eastern region was 3.26 per cent more than the Bunelkhand region. Similarly, the farm power value in eastern region is 62.11 per cent more than Bundelkhand region and average total energy value in eastern plain zone is 72.38 per cent more than Bundelkhand region. And also other parameters of eastern region were also high in comparison to Bundelkhand as shown in Table 1. The degree of mechanization of different farm implements in different unit operation is also shown in Fig. 3 and 4. From the Table 2, it was also found that the degree of mechanization in eastern region is more than Bundelkhand region but threshing operation and diesel pumps are more mechanized in Bundelkhand region than eastern region.

Table 1: Mechanization status parameters of Bundelkhand and Eastern region in Uttar Pradesh

Sr. No.	Mechanization status parameters	Bundelkhand region (Average values)	Eastern region (Average values)
1.	Mechanization index	0.921	0.951
2.	Farm power (kW/ha)	1.61	2.61
3.	Cropping intensity (%)	124.59	160.42
4.	Irrigation intensity (%)	124.59	160.42
5.	Annual farmers income (Rs.)	119852	177125
6.	Annual input cost (Rs.)	32463	49586
7.	Human energy (kWh/ha)	26.63	81.98
8.	Mechanical energy (kWh/ha)	400.31	655.49
9.	Total energy (kWh/ha)	426.94	735.94

Table 2 : Degree of mechanization of different farm implements in Bundelkhand and Eastern region of U.P.

Degree of mechanization	Bundelkhand region (Average values)	Eastern region (Average values)
Cultivator	0.469	0.558
Power tiller	0.001	0.000
Disc plow	0.002	0.139
M B plow	0.00	0.005
Desi hal	0.00	0.000
Disc harrow	0.005	0.168
Leveller	0.011	0.049
Puddler	0.00	0.287
Bundmaker	0.00	0.006
Rotavator	0.00	0.000
Seed cum ferti drill	0.364	0.013
Diesel engine	0.464	0.238
Electric Pump	0.00	0.250
Sprinkler	0.00	0.002
Dripper	0.00	0.000
Spray manual	0.284	0.379
Spray tractor	0.00	0.001
Harvesting worker	0.993	0.996
Harvesting harvester	0.007	0.016
Thresher	0.393	0.289

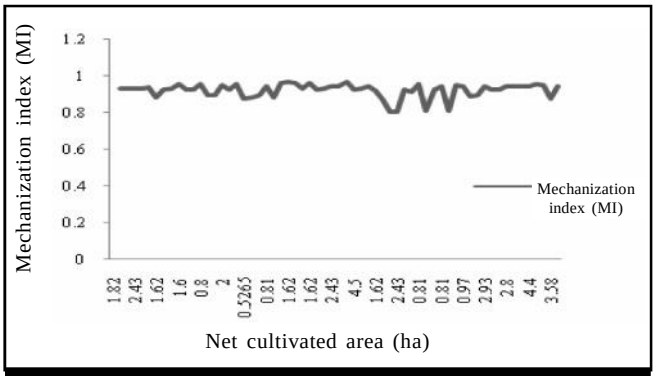

Fig. 1 : Variation in mechanization index with net cultivated area in Bundelkhand zone

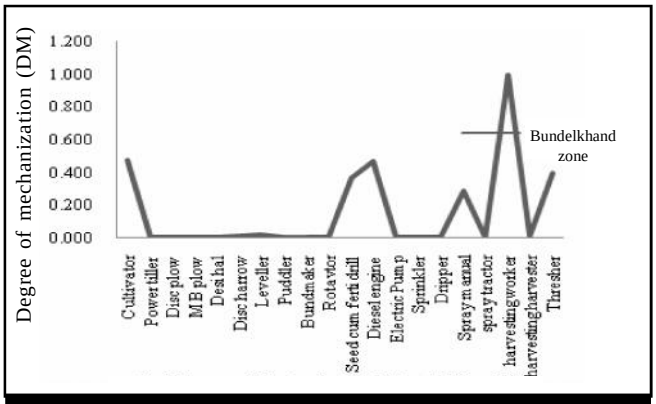

Fig. 3 : Degree of mechanization in Bundelkhand zone

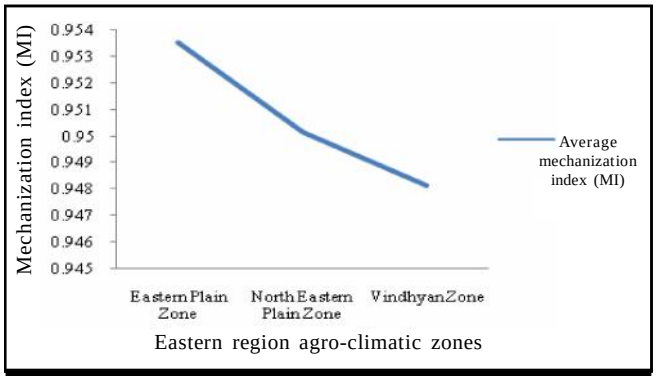

Fig. 2 : Variation in mechanization index with Eastern agro-climatic zones

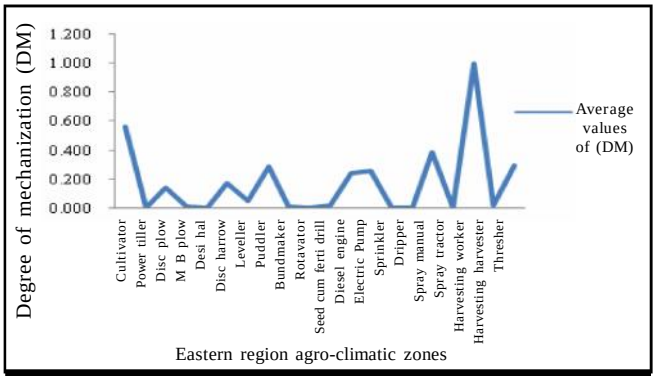

Fig. 4 : Variation of degree of mechanization with Eastern agro-climatic zones

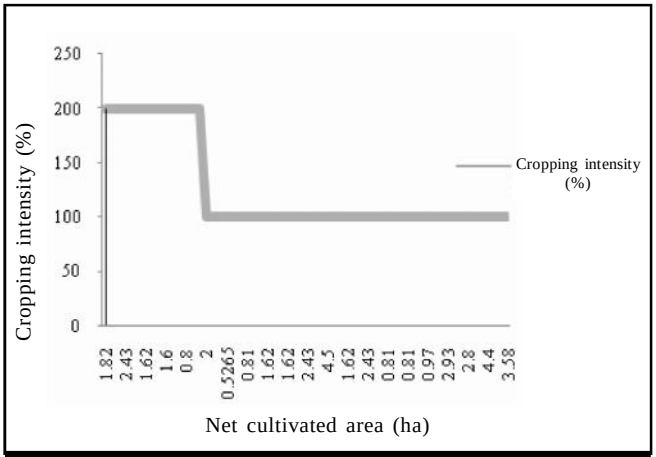

Fig. 5 : Vatiation of cropping intensity with net cultivated area in Bundelkhand zone

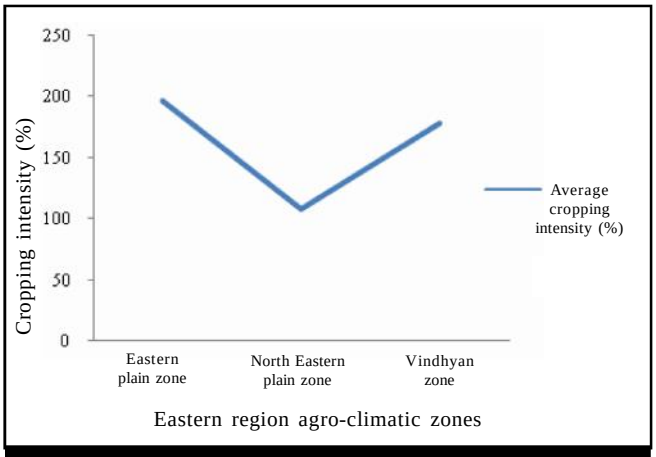

Fig. 6 : Variation of cropping intensity with eastern agro-climatic zone

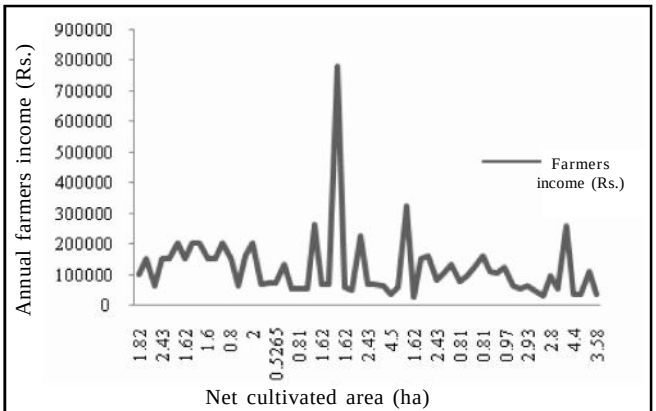

Fig. 7 : Variation of farmers income with net cultivated area in Bundelkhand zone

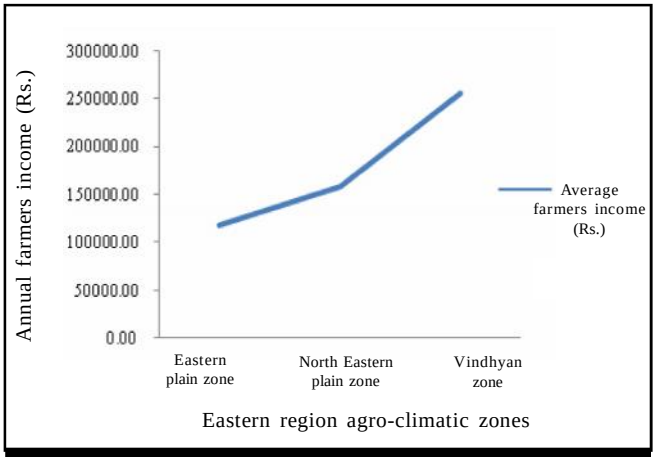

Fig. 8 : Variation of farmers income with Eastern agro-climatic zones

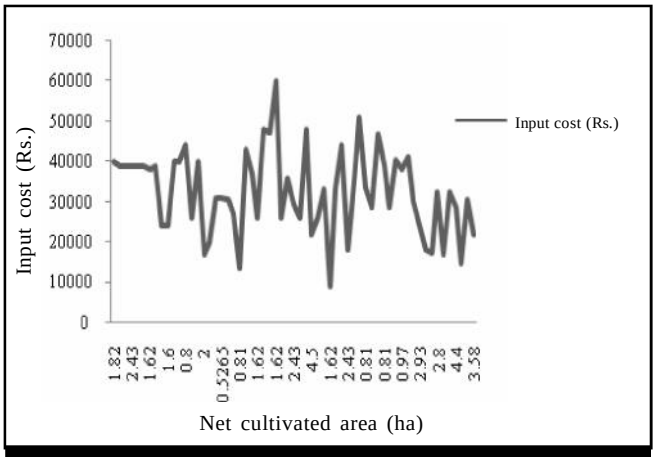

Fig. 9 : Variation of input cost with net cultivated area in Bundelkhand zone

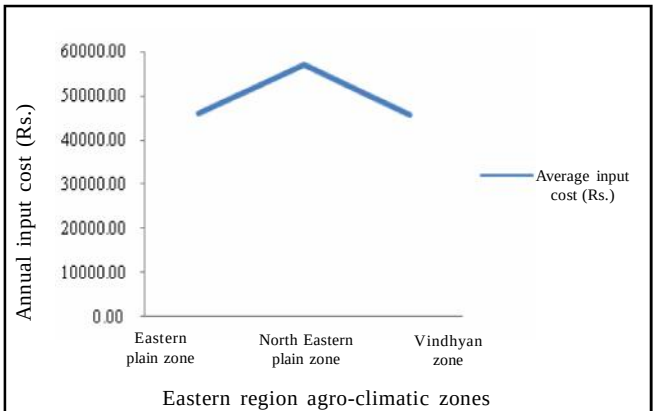

Fig. 10 : Variation of input cost with Eastern agro-climatic zones

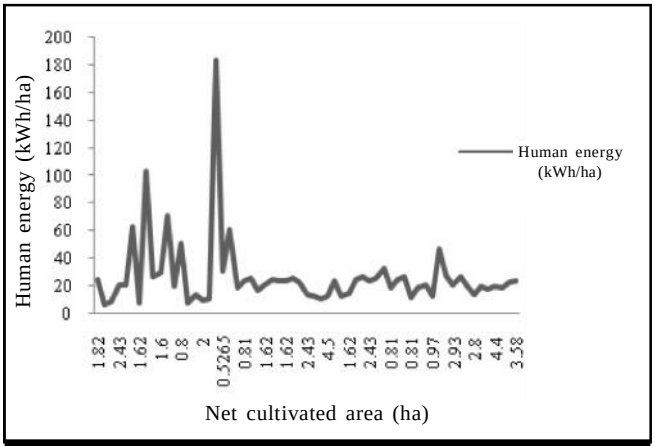

Fig. 11 : Vatiation of human energy with net cultivated area in Bundelkhand zone

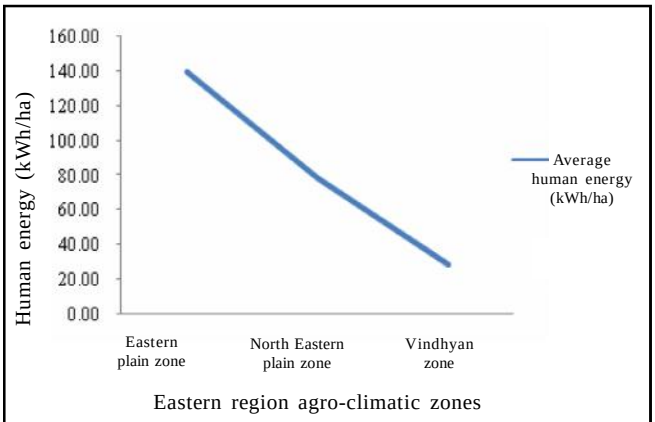

Fig. 12 : Variation of human energy with eastern agro-climatic zone

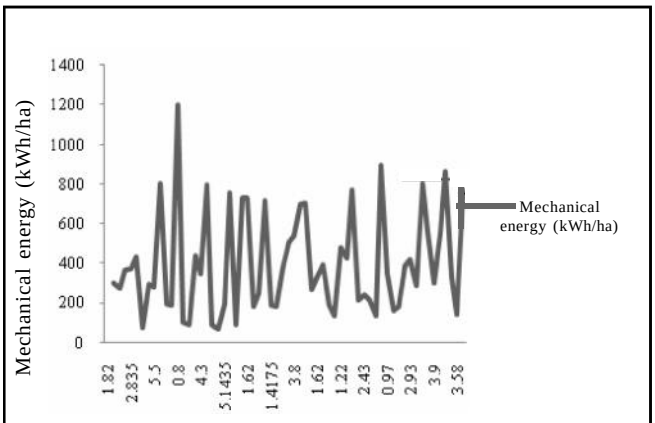

Fig. 13 : Variation of mechnical energy with net cultivated area in Bundelkhand zone

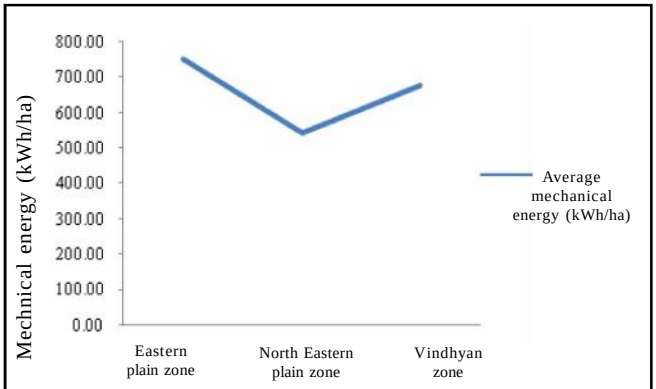

Fig. 14 : Variation of mechanical energy with Eastern agro-climatic zones

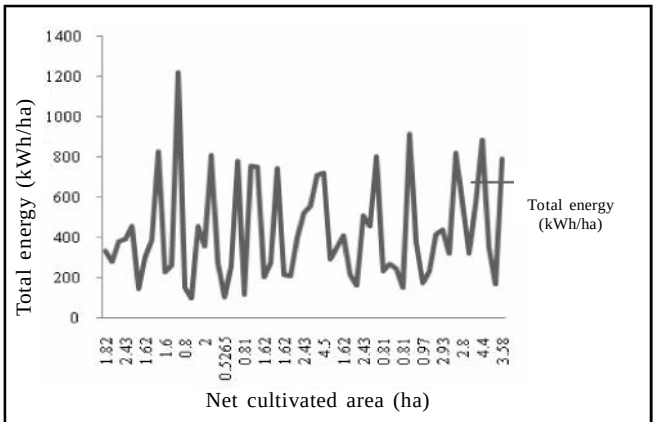

Fig. 15 : Vatiation of total energy with net cultivated area in Bundelkhand zone

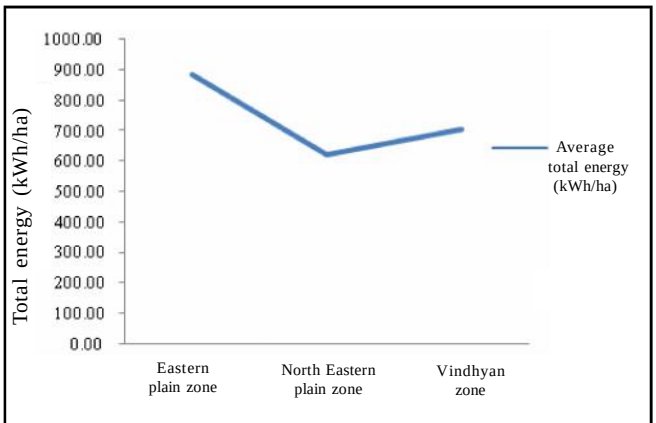

Fig. 16 : Variation of total energy with eastern agro-climatic zone

Conclusion:

The mechanization index, power availability, cropping intensity, irrigation intensity, annual farmers income, annual input cost, mechanical energy, total energy were higher in western region in comparison to eastern region but human energy was more in eastern region than Bundelkhand region. The average value of mechanization index, power availability, cropping intensity, irrigation intensity, annual farmers income, annual input cost, human energy mechanical energy, total energy in Bundelkhand region and eastern region of Uttar Pradesh were 0.921, 1.61 kW/ha, 124.59 per cent, 124.59 per cent, Rs. 119852, Rs.32463, 26.63 kWh/ha, 400.31 kWh/ha and 426.94 kWh/ha, 0.951, 2.61 kW/ha, 160.42 per cent, 160.42 per cent, Rs.177125, Rs.49586, 81.98 kWh/ha, 655.49 kWh/ha and 735.94 kWh/ha, respectively. Similarly, degree of mechanization was highest in eastern region than Bundelkhand region but threshing operation and diesel pumps are more mechanized in Bundelkhand region than eastern region.

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