Original Research Article

Quantification of Agricultural Mechanization Status for Etawah District of Uttar Pradesh, India

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A B S T R A C T

District Etawah falls in western part of Uttar Pradesh. The district has 8 blocks and 696 villages. The net sown area of the district is 1.48 lakh ha with cropping intensity of 210 %. Normal annual rainfall of the district is 792 mm. Three main levels of mechanization technologies need consideration: human power, animal power and mechanical power technologies, with varying degrees of sophistication within each level, on the basis of capacity to do work, costs, precision and effectiveness. After selection of variables, a questionnaire was prepared to collect primary data from Etawah district of Uttar Pradesh. A Stratified Multistage Sampling Design was applied considering district and blocks as strata. The villages were selected from each block of Etawah district using random sampling and 4 blocks out of 8 blocks of Etawah district were taken for the study. Then from each blocks, villages and then from each villages, 15 farmers were selected using random sampling. Primary data were collected from 600 farmers from 40 villages. The Mechanization index, Power availability, Total energy, Mechanical energy, Human energy is highest in Basrehar block significantly in comparison to other three blocks ie 0.953, 1.877 kW/ha, 1990.32 kWh/ha, 1930.57 kWh/ha, 59.59 kWh/ha,. The average value of Mechanization index, Power availability, Total energy, Mechanical energy, Human energy, cropping intensity, Irrigation intensity, farmers income and input cost in Etawah district is 0.9416, 1.53 kW/ha, 1250.59 kWh/ha, 1199.73 kWh/ha, 50.95 kWh/ha, 210 %, 799.84 %, Rs.143885 and Rs. 53729 respectively.

Introduction

District Etawah falls in western part of Uttar Pradesh and is surrounded by Mainpuri, Agra, Auraiya and state Madhya Pradesh. The district has 8 blocks and 696 villages. The total area of the district is 2434 square km, supporting a population of 15.82 lakh with population densely as 684 persons per square km. The district is endowed with Chambal and Yamuna rivers. The net sown area of the district is 1.48 lakh ha with cropping intensity of 155%. Normal annual rainfall of the district is 792 mm. More than 74% of the net sown area is irrigated and over 69% land is cultivated. The net irrigated area of the district is 1.34 lakh ha. The climate is semi-arid arid the soil type is alluvium calcareous clay.

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 (Rijk, 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 Rijk, 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 equations (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.

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

Where,

MI = Mechanization Index for the production unit `a`,
Me (i) = Overall input energy due to machinery in the production unit `a`,
Mav = Regional-average energy due to machinery,

Li =Land area cultivated in the production unit `a`,
TLi = 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 Equation (1) includes a ratio between the land area cultivated with soybean 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.

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

Where, LOM = level of mechanization,
Pi= 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).

Mechanization level
$$(hp/ha) = \frac{Total\ Power}{Cultivated\ Area} \qquad \cdots (3)$$
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 coefficient (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) can also be calculated in the same manner.

Materials and Methods

After selection of variables, a questionnaire was prepared to collect primary data from Etawah district of Uttar Pradesh. A Stratified Multistage Sampling Design was applied considering district and blocks as strata. The villages were selected from each block of Etawah district using random sampling and 4 blocks out of 8 blocks of Etawah district were taken for the study. Then from each blocks, villages and then from each villages, 15 farmers were selected using random sampling. Primary data were collected from 600 farmers from 40 villages. As mechanization is a multi-dimensional concept, thus the following indices were evaluated to study the mechanization status in target region.

To study the mechanization status of Etawah district of Uttar Pradesh, 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)

In other words, the degree of mechanization can be used to evaluate the extent of different agricultural operations performed using machinery or improved implements to the operations performed by humans, animals or traditional implement ie Area under bullocks, cultivator, power tiller, disc plough, M B plough, deshi hal (local plough), seed cum fertilizer drill, diesel engine, electric pump, sprinkler, dripper, sprayer (manually operated), sprayer (tractor operated), manual harvesting, thresher and combine harvester.

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. The mobile power is used for different field jobs like land preparation, sowing, weeding, spraying, and harvesting etc., whereas stationary power is used for lifting water, operating irrigation equipment, threshing, cleaning and grading of agricultural produce. The main sources of mobile power are human, draught animal, tractors, power

tiller and self-propelled machines (combines, dozers, reapers, sprayers and etc.) where as the source of stationary power is oil engines and electric motors. In this study, power availability was also evaluated for Etawah district 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 Etawah District. 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

Mechanization index (MI)

Farm operation wise mechanization index is one of the quantitative measures of mechanization and it can be defined as per capita power in terms of hp per hectare for a particular region. Evaluation of operation wise mechanization index first then Farmers wise human power, animal power and machinery power availability like tractor, thresher, combine. In this study, a new approach to evaluate Mechanization Index was used to overcome the demerits in the previous methodology to evaluate Mechanization Index and is given below:

$$MI_i = \frac{\sum\limits_{j=1}^{r}\sum\limits_{k=1}^{s}(M^p_{jk} \times M^t_{jk})}{}$$

$$\frac{\sum\limits_{j=1}^{r}\sum\limits_{k=1}^{s}(M^p_{jk} \times M^t_{jk} + H^p_{jk} \times M^t_{jk} + A^p_{jk} \times A^t_{jk})}{} \quad …(6)$$

Where,

MI_i = Mechanization Index of ith farm

M^p_{jk} = Power of machine used in kth operation in jth crop (including stationary and movable)

M^t_{jk} = Time taken by machine to perform kth operation in jth crop H^p_{jk} = Power of human used in kth operation in jth crop (including stationary and movable)

H^t_{jk} = Time taken by human to perform kth operation in jth crop

A^p_{jk} = Power of animal used in kth operation in jth crop (including stationary and movable)

A^t_{jk} = Time taken by animal to perform kth operation in jth crop

i = 1 to n, where n is number of farm j = 1 to r, where r is number of crop cultivated in a calendar year

k = 1 to s, where *s* is no of farm practices in *j*th cro

Results and Discussion

The graphical representation of variation of Mechanization index, Power availability, Total energy, Human energy, Mechanical energy, Degree of mechanization, Cropping intensity, Irrigation intensity, Farmers income and Input cost in four blocks i.e. Mahewa,

Saifai, Badpura, Basrehar are shown in figure from 1 to 13. The average value of above mentioned parameters are also given in Table 2. The several farm mechanization parameters and their variability among different blocks were also studied using one way ANOVA. It was observed that Mechanization index, Power availability and other parameters varied significantly among blocks (Table 1).
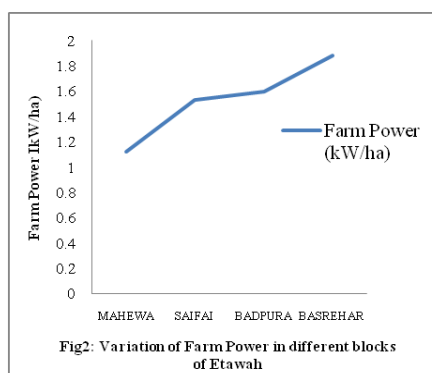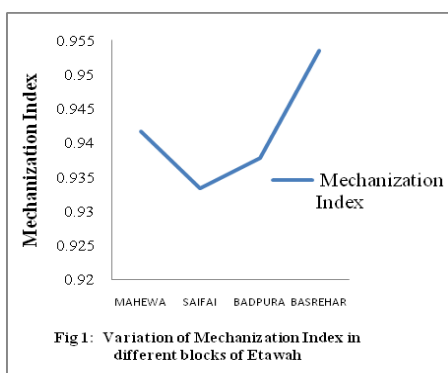
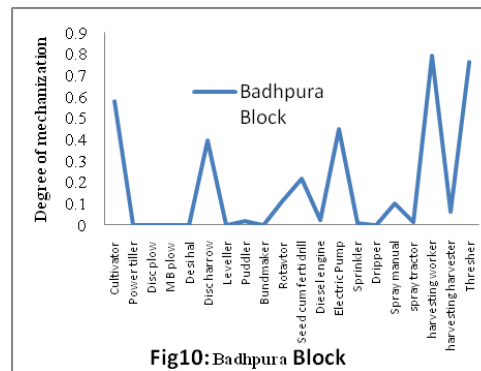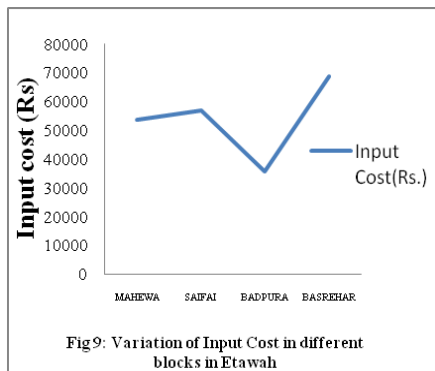**Table.1** ANOVA for mechanization parameters

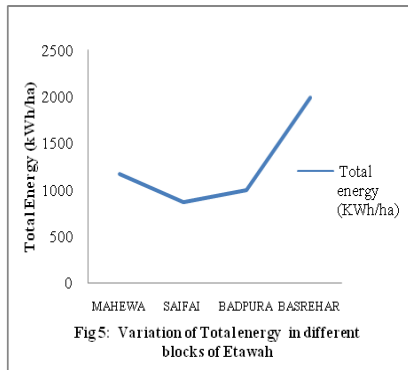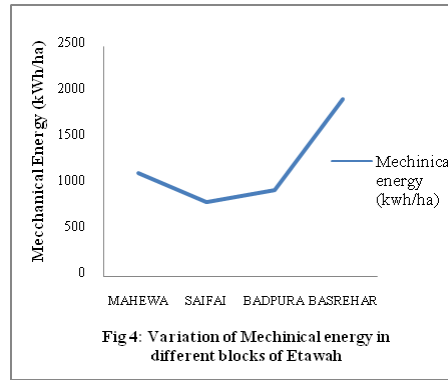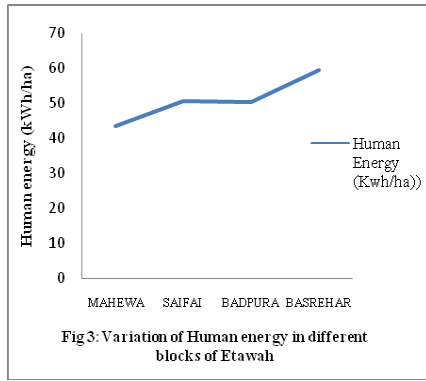| Source	DF	p-values				
Model	3	Mechanization Index	Total Energy (kWh/ha)	Human Energy (kWh/ha)	Mechanical Energy (kWh/ha)	Power availability (kW/ha)
Error	16	0.0067	0.0050	0.0474	0.0056	0.0241
Total	19					
R²	-	0.258	0.541	0.382	0.534709	0.248
CV	-	1.668	47.120	38.18	48.81804	62.031

Table.2 Comparison of mechanization parameters

Parameters	Block				LSD
	Mahewa	**Basrehar**	**Badpura**	**Saifai**	-
Mechanization Index	0.9416c	0.9535a	0.9378b	0.9333b	0.0285
Total Energy (kWh/ha)	1164.25b	1990.32a	987.49c	860.70d	1042.7
Human Energy (kWh/ha)	43.46c	59.59a	50.24b	50.53b	33.969
Mechanical Energy (kWh/ha)	1120.80b	1930.73a	937.25c	810.17d	1036.8
Power availability (kW/ha)	1.1184d	1.8777a	1.5945b	1.5248b	1.7793

Fig.1–13

Fig 1: Variation of Mechanization Index in different blocks of Etawah

Fig2: Variation of Farm Power in different blocks of Etawah

Fig 3: Variation of Human energy in different blocks of Etawah

Fig 4: Variation of Mechinical energy in different blocks of Etawah

Fig 5: Variation of Total energy in different blocks of Etawah

Fig 6: Variation of Cropping Intensity in differnt blocks of Etawah

Fig 7: Variatio of Irrigation Intensity in different blocks of Etawah

Fig 8: Variation of Farmers Income in different blocks in Etawah

Fig 9: Variation of Input Cost in different blocks in Etawah
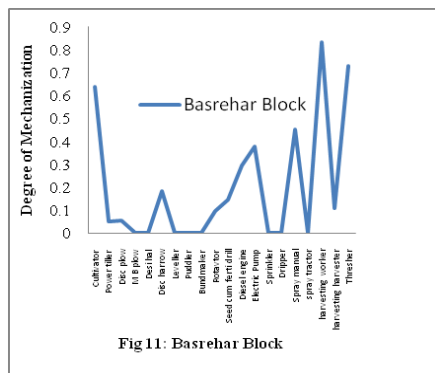

Fig10: Badhpura Block
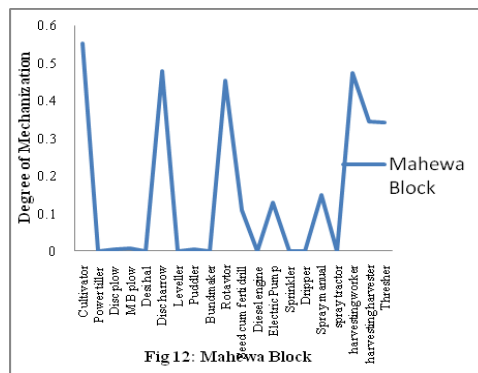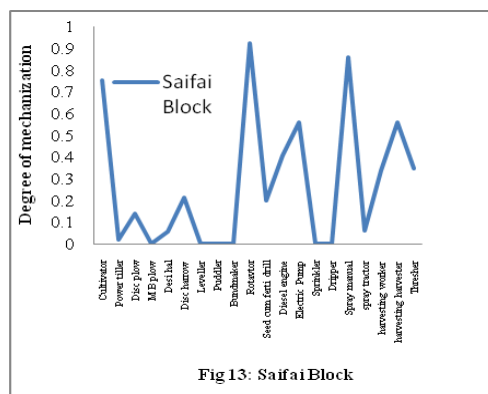
Fig 11: Basrehar Block

Fig 12: Mahewa Block

Fig 13: Saifai Block

The comparisons of parameters for different blocks has been performed using LSD values and presented in (Table 2). It can be seen that Mechanization index, Power availability Total energy, Human energy and Mechanical energy varied significantly in different across blocks (Table 2).

In conclusion, the Mechanization Index, Power availability, Total energy, Mechanical energy, Human energy is highest in Basrehar block significantly in comparison to other three blocks as mentioned in above Table 2. Buts the Badpura and Saifai have almost same insignificant value Mechanization Index and Power availability. The average value of Mechanization Index, Power availability, Total energy, Mechanical energy, Human energy, cropping intensity, Irrigation intensity, farmers income and input cost in Etawah district is 0.9416, 1.53 kW/ha, 1250.59 kWh/ha, 1199.73 kWh/ha, 50.95 kWh/ha, 210, 799.84, Rs.143885 and Rs. 53729 respectively.

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