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**Er. Vaibhav H Jadhav**
M-Tech Department of Farm Machinery and Power Engineering, SHUATS, Prayagraj, Uttar Pradesh, India

**Vishal R Wankhade**
Assistant Professor, College of Agricultural Engineering and Technology, Jalgaon Jamod, India

**Corresponding Author**
**Er. Vaibhav H Jadhav**
M-Tech Department of Farm Machinery and Power Engineering, SHUATS, Prayagraj, Uttar Pradesh, India

# Status of energy use efficiency for wheat production in district Prayagraj, Uttar Pradesh

## Er. Vaibhav H Jadhav and Vishal R Wankhade

**Abstract**
The use of energy in agricultural have increased, making it necessary to make current agricultural practices more energy efficient. To do this, the prevailing system must be thoroughly analysed. Studies have focused on assessing the energy performance of individual crop, but notably few studies have investigated in wheat crop. Wheat covers approximately 35% of the total global area devoted to by cereal crops. Wheat production needs to be augmented to meet the growing demand. The basic purpose of the present study is to analyse and optimize energy use patterns of wheat production in district Prayagraj of Uttar Pradesh to maximize yield. This study was conducted in the one important district in the Prayagraj (Uttar Pradesh) during 2020. Total of 200 farmers were selected randomly from all the 10 villages. This study aims to assess the energy input output, energy use efficiency for wheat production. The effect to different land size on Energy Use Efficiency was also assessed and analysed statistically. In the Wheat production EUE was found maximum in the larger land category with the average value of 6.19 and it showed a reducing trend as the land size decreased. The Energy Use Efficiency decreased to an average value of 5.67 for small land holding and again further reduced to 5.60 in the marginal land holdings. The overall Energy Use Efficiency of wheat crop 5.79.

**Keywords:** Energy input and output, energy use efficiency

## 1. Introduction
India is a predominantly agricultural country. About 70% of its population depends on agriculture. Wheat and rice are the two major cereal crops that occupy about 50–55% of the total cropped area of India. Wheat alone covers about 25% of the total area covered by cereal crops. Wheat flour is mostly used for making Chapati and bread. Major wheat growing states in India are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar and Gujarat. (*Triticum aestivum* L.) is one of the most cultivated crops in temperate climates. use of energy in the agriculture sector has directly or indirectly been intensified to increase crop production to fulfil the food demand of the rapidly growing population. Wheat production is a direct function of high yielding varieties, chemicals, fertilizers, mechanization and other energy inputs. Both energy use and costs are ever-increasing in the agricultural sector. Since the green revolution and the promotion of high-input, mechanised, irrigated cropping systems, agriculture uses much energy, directly and indirectly, owing to its many production activities, inputs and requirements: land preparation, tillage, fertilisers and agro chemicals (manufacturing and application), irrigation (pumping), harvesting and the likes. Therefore, increased energy efficiency has become a key objective for both farmers and policymakers; Wheat is a main cereal crop cultivated throughout the world along with rice, maize, rye, oats, and millet. It is grown under irrigated as well as tainfed conditions worldwide. Based on Ministry of Agriculture and Farmers Welfare of India statistics, India produced about 98.38 million tonnes of wheat in 2016-17. Energy is one of the most valuable inputs in agriculture for crop production.

From this perspective, the agricultural sector has an important role as both a consumer and a producer of energy. The growing worldwide demand of energy by the agricultural sector to meet the food demand of more than 7 billion people results in detrimental effects on the environment and the health of the farmers. If the energy in agricultural sector is used judiciously, it will not only reduce the environmental impacts in terms of greenhouse gases (GHG) emissions and other hazardous effects but will also lead to a desirable sustainable form of agriculture.

According to the World Bank estimates, half of the Indian population would be urban by the year 2050.

It is estimated that percentage of agricultural workers in total work force would drop to 25.7% by 2050 from 58.2% in 2001. Total geographical area of the Uttar Pradesh is 24,170 thousand hectare (which is 7.33% of total area of India) out of which 16,573 thousand hectare is under cultivation. Gross cropped area is 25,414 thousand ha with the cropping intensity of 153%. In Utter Pradesh size of holding is around 0.83 ha and per capita land area is 0.14 ha, which is less than a half of the national average of 0.32 ha. Utter Pradesh is largest producer of wheat, potato, sugarcane and third largest producer of rice.

Uttar Pradesh is the largest state with maximum contribution towards national production (35.03%) from the large area (35.12%), but with productivity on a lower side of 2.7 tonnes/ha. The wheat production is distributed in three agro climatic zone, viz. Western Uttar Pradesh (3.29 million ha.), eastern (Prayagraj District falls in the east) Uttar Pradesh (5.24 million ha) and central Uttar Pradesh (0.68 million ha). The yield gap between farmers' fields and frontline demonstration is 1.35 tonnes/ha. The area is 9.2 million ha, with production of 24.5 million tonnes and productivity of 2.7 tonnes/ha. the major constraints in production are decreased soil organics carbon status, nutrient mining, Imbalanced fertilization, crop residue burning leading to nutrient and organic carbon loss, declining water table and late sowing under sugarcane, wheat and after potato in western Uttar Pradesh.

The survey of the calculate Energy Use Efficiency (EUE) of wheat crop target area in Prayagraj (Uttar Pradesh). Data was collected from the one important district in the Prayagraj (Uttar Pradesh), through direct face-to-face interviews with the farmers using the one cropping (wheat) systems during the period of January - April 2020. A total of 200 farmers were engaged in the wheat (mainly in Prayagraj district) cropping systems.

## 2. Materials and Methods

The primary data for energy input resources were collected by field surveys and personal interview of farmers through questionnaire. Secondary data for energy input resources and energy outputs were obtained from the available information in literatures and other resources The mechanical energy dissipated in mechanical operations and energy consumed in other activities, such as irrigation, transportation and other inputs, were estimated from on- and off-farm energy input.

The actual values of all the inputs used were calculated based on the results of a survey of the target area. Data was collected from the one important districts in the Prayagraj (Uttar Pradesh), through direct face-to-face interviews with the farmers using the one cropping systems during the period of January - April 2020. The sample size was calculated by the formula given by Yamane (1967) and a total of 200 farmers were engaged in the wheat (mainly in Prayagraj district) cropping systems, respectively, were interviewed in the selected areas. This was based on the number of farming households following a particular cropping system in a particular village of the study areas. District Prayagraj is situated in the South-Eastern part of the State Uttar Pradesh. It lies between the parallels of 24º 47' north latitude and 81º 19' east longitudes. Prayagraj district is on the eastern side. From north to south the breath is 109 kms and from east to west length is 117 kms. The total geographical area of the district is 5437.2 (as per 1991 data) sq.kms. The rivers 'Ganga and Jamuna divides Allahabad in three distinct regions namely, Gangapaar, Jamunapaar and Dwaba. There are 7 Tehsils and 20 blocks in Prayagraj District Uttar Pradesh. Allahabad district has such tropical climate that the average maximum temperature ranges between 43 $^{0}$C – 47 $^{0}$C which may go as high as 480C during peak summers. The minimum average temperature is 2-4 $^{0}$C which may fall as low as 1.5 $^{0}$C during peak winter months (Dec.-Jan.) The average rainfall of the district is 960 mm and the monsoon season is spread between July-September. Wheat is a major crop production in Prayagraj district. A total wheat crop area is 211378ha. My study is calculating Energy Use Efficiency of wheat production in the selected study area.

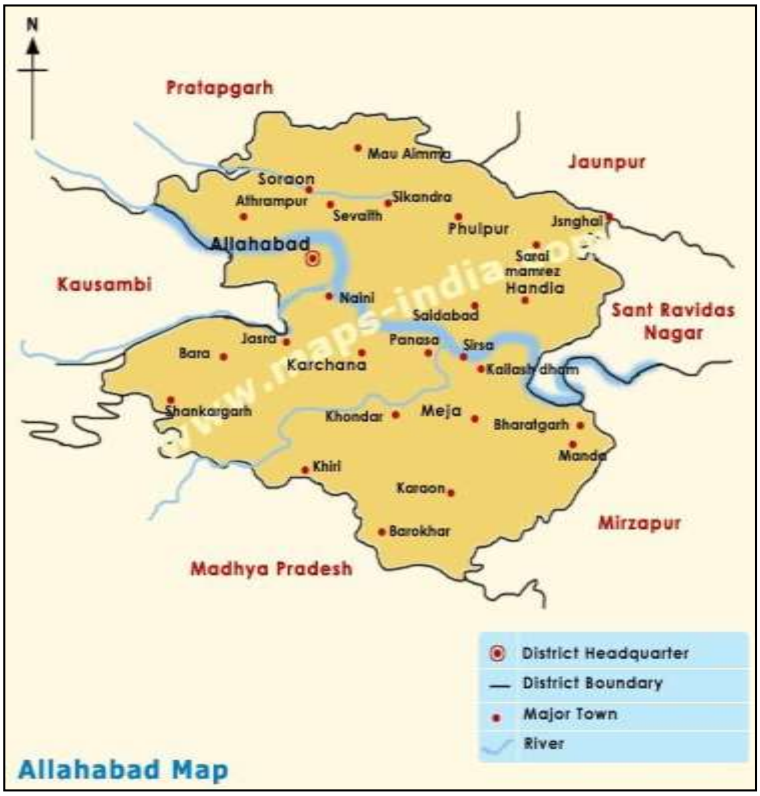


**Fig 1:** Prayagraj District Map

### 2.1 Data collection

**1) Primary data collection:** The survey of about 200 farmers was collected, grouped under three categories on the basis of size of land, input power used and the yield. Along with other economic factors such as cost of cultivation, machinery cost, cost of human and animal labour etc. in the different Teshil of Prayagraj district of Uttar Pradesh.

**2) Secondary data collection:** The secondary data refer to information that has been collected earlier by someone else. Often this is printed and published reports or trade statistics etc.

### 2.2 Classification of Land size

**In India the land is classified on four bases:** 1) Marginal 2) Small 3) Medium 4) Large.

1. **Marginal land:** Farms having less than 1ha area are classified as marginal farms (<1.0 ha)
2. **Small land:** Farms which have more than 1hactare but less than 2hactare area are classified as small farms.
3. **Medium land:** Farms which have more than 2hactare but less than 4hactare area are classified as medium farms.
4. **Large land:** Farms which have more than 10hactare land are classified as large farms.

But for our study we are considering only four farm categories which were available in the study area; namely Marginal, Small, Medium and Large category.

### 2.3 Energy use

1. **Calculation of energy input: Energy input (MJ/ha.) =** Use of input (unit)×Energy Equivalent (MJ/unit)
2. **Calculation of energy output: Energy output (MJ/ha.)** = {grain production in (kg /ha.) × Energy Equivalent (MJ/kg.) + Byproduct production (kg/ha.) × Energy Equivalent (MJ/kg)}

**Table 1:** Energy equivalents for various input and output energy forms

| Energy | Unit Energy equivalent coefficient (MJ/Unit$^{-1}$) | Unit |
|---|---|---|
| **Inputs** | | |
| Human labour | 1.96 | h |
| Machinery | 62.7 | h |
| Diesel Fuel | 56.31 | L |
| Chemical Fertilizers | | |
| 1) Nitrogen | 66.14 | Kg |
| 2) Phosphorous | 12.14 | |
| 3) Potassium | 11.15 | |
| Herbicides | 238 | Kg |
| Water | 1.02 | m$^3$ |
| Electricity | 11.93 | kW/h |
| Seed | 14.7 | Kg |
| **Output** | | |
| Wheat Grain Yield | 14.7 | Kg |
| Wheat Straw Yield | 12.5 | Kg |

Based on energy equivalents given table 1; energy indices include energy use efficiency.

**Energy Use Efficiency (EUE):** Energy Use Efficiency indicates how efficient a crop production system is in terms of its energy input and output where the output is calculated in term of the energy indices that indicate the efficient use of energy in agriculture, and this ratio has been used to express ineffectiveness of an agricultural production system. Any augment in EUE indicates efficient use of available energy for agricultural use, and vice versa.

**Formula (EUE) =** Total Output Energy (MJ/ha$^{-1}$.)/ Total Input Energy (MJ/ha$^{-1}$.)

## 3. Result and Discussion

### 3.1 Energy Input

Prevailing management practices and the energy input source involved in each of the activities for the different farm size the result showed that fertiliser use was the greatest input energy in wheat crop Nitrogen in particular was the largest contributor of the fertilizer input followed by phosphorus, these values reflect the mindset of the farmers, who believe that yield depends directly on the amount of fertilizer used and have no concerns about the environmental impacts created by fertilizer usage. Fuel was the second highest contributor, of total energy. Most of the fuel based energy inputs were attributed to the consumption of diesel oil in various on farm agricultural activities. Fig.2 shows the effect of farm size on total energy inputs in the different farm operation of wheat production. The findings of this study are in line with those of other similar studies that were carried out for the selected crops (Wheat, paddy, potato) which reported fertilizer and fuel as the main contributors to the energy input pool reported an input energy for the production of wheat crop in agreement with the results of this study.

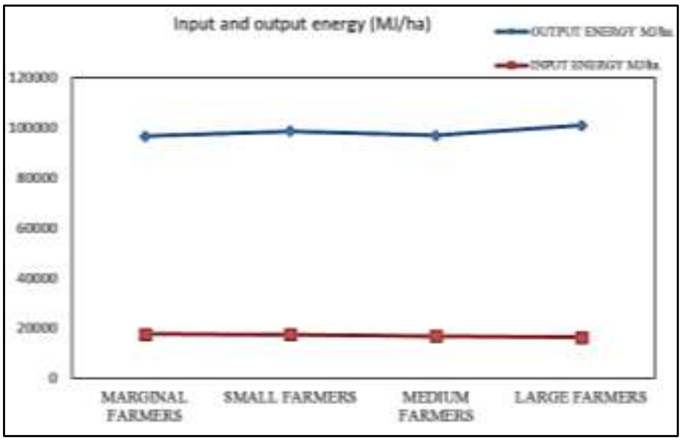


**Fig 2**: Energy input and output in different type of farm size MJ/ha.

### 3.2 Energy Output

Energy output from the wheat production is attributed to average crop biomass production, which included grains and straw. The energy output from different crop biomass production is given in Table 2. The sum of grain and straw production in wheat crop is considered as total output. The relation between input and output of different farms shown in fig.3.

**Table 2:** Energy in output MJ/ha.

| Particulars | Energy in grain and by-product of wheat crop | |
|---|---|---|
| | Grain yield | By-product |
| **Output MJ/ha.** | 49083.3 | 50178.45 |

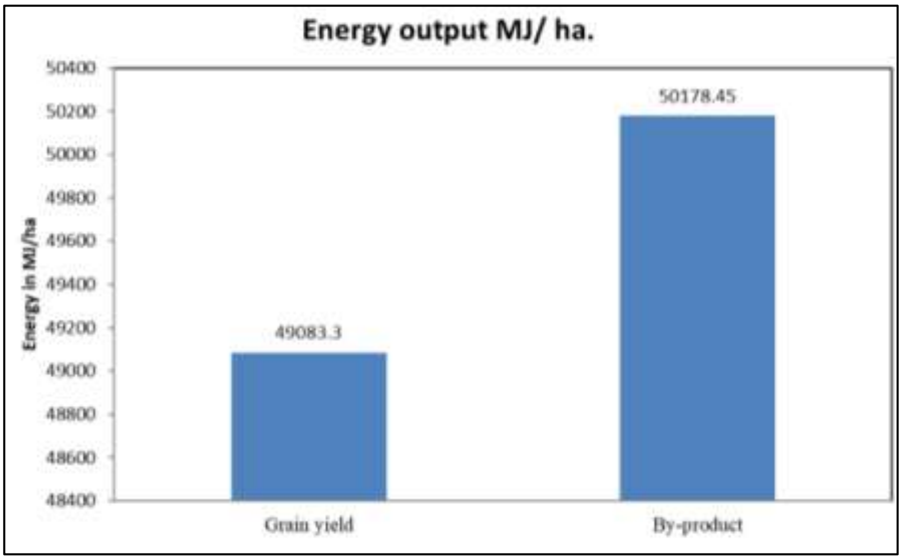


**Fig 3:** Energy output in grain and by-product of wheat crop (MJ/ha.)

**Table 3:** Energy Use Efficiency in different type of farm size

| Type of Farmer | Energy Use Efficiency |
|---|---|
| Marginal Farmers | 5.60 |
| Small Farmers | 5.67 |
| Medium Farmers | 5.87 |
| Large Farmers | 6.19 |

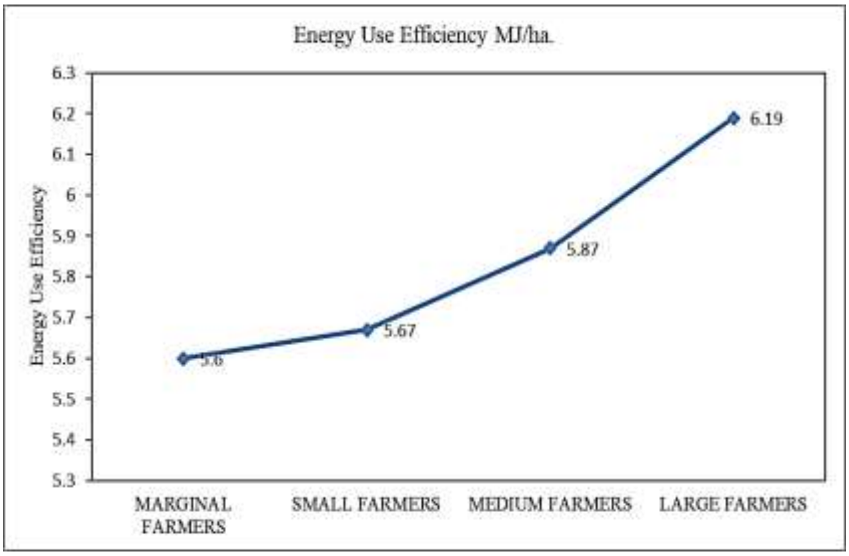


**Fig 4:** Energy Use Efficiency in different type of farm size MJ/ha.

### 3.3 Effect of different land size on the Energy Use Efficiency

The effect of different land size on Energy Use Efficiency was also assessed and analyzed statistically. In the wheat production EUE was found maximum in the larger land category with the average value of 6.19 and it showed a reducing trend as the land size decreased. The Energy Use Efficiency decreased to an average value of 5.67 for small land holdings and again further reduced to 5.60 in the marginal land holdings. The average farm size in the India is becoming smaller, and small land holding are becoming predominant. In both the systems, a trend of increasing input energy was observed with the decrease in farm size. Input energy in the form of human power decreased as the land size increased, which clearly reflects the dependency of farmers with small land holding on human labour. In the study area, it was noted that use of family labour was higher in the small land holding.

## 4. Conclusion

The Prayagraj District Uttar Pradesh has the main occupation of the population residing is agriculture. The large area of the district is under wheat cultivation. The study aimed at evaluating the wheat in this region in terms of their energy use of farmers' field. Data were collected from 200 farmers which were selected based on random method. Face to face questionnaire method was used in obtained the data. The results obtained can be summarized. The overall energy use efficiency of wheat crop was 5.80. In this way about the possibilities of increasing the efficiency of agricultural production can be progress. Energy use in wheat production is not efficient and detrimental to the environment due to mainly excess input use. Reducing these inputs would provide more efficient fertilizer application and diesel. It can be expected that all these measurements would be useful not only for reducing negative effects to environment, human health but also for providing higher energy use efficiency.

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