

Original Research Article

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Energy Use Pattern and Energy Efficiency of Mechanised Rice Production in West Godavari District of Andhra Pradesh, India

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ABSTRACT

Energy use pattern and energy efficiency of fully and partially mechanised rice production in West Godavari district of Andhra Pradesh state were estimated using energy input-output ratio analysis. The primary data was collected from 122 respondents during the year 2017-18. The indicators are net energy, energy use efficiency, specific energy, energy productivity. The energy equivalents were obtained from available literature by using the collected data. Analysis of data showed that average fertilizer had the highest share within the total energy input in both the systems followed by mechanization and irrigation in fully mechanized farms and irrigation and human labourer in partially mechanized farms. Energy use efficiency was calculated as 1.94 in fully mechanized farms and 1.45 in partially mechanized farms. The total energy input in rice production in fully mechanized farms (54,719 MJ/ha) was found to be less than partially mechanized (64,824 MJ/ha). The net energy from the fully mechanized farms (51,287.46 MJ/ha) was higher than that from the partially mechanized farms (29,178 MJ/ha). There were no significant changes regarding herbicides and irrigation in both the systems.

Keywords

Rice,
Mechanisation,
Energy, Efficiency,
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Introduction

Agriculture is the most important sector in Indian economy and it is basically an energy conversion industry. Energy is one of the most valuable inputs in agricultural production. The energy use pattern of crops varies under different agro climatic zones. The use of energy in crop production depends on the availability of energy sources and the

capacity of the farmers. Agricultural productivity is proportional to energy input in the form of improved seed, fertilizers, chemicals, irrigation and mechanization including management practices (Kalbande and More, 2008). Energy is invested in various forms such as mechanical (farm machines, manual labour, and animal draught), chemical (fertilizer, pesticides, herbicides), electrical, etc., (Pimentel, 1992).

Efficient use of the energy resources is vital in terms of increasing productivity and developing sustainable agricultural practices. Rice is a staple food crop, Andhra Pradesh ranked third position in rice with 23.79 lakh hectares of area, 92.27million tonnes of production and 3941 kg/ha productivity (TE, 2015-16). West Godavari district has 3,99,000 ha area under rice crop, which is the principal crop grown in the district. Rice is produced using different energy sources ranging from human and animal to heavy machinery.

Andhra Pradesh Government is providing machinery on subsidy basis to rice farmers and some farmers employing machinery for the operations like puddling, transplanting, harvesting in rice. In West Godavari district the major ongoing schemes to supply machinery on subsidy basis are Rashtriya Krishi Vikas Yojana (RKVY)-Remunerative Approaches for Allied and Agriculture Sector Rejuvenation, National Food Security Mission (NFSM), Sub Mission on Mechanisation and Rythu Radham. Employing machinery and equipment for certain operations remove the drudgery, increase the productivity besides saving time. Evaluating the alternate management practices followed by better management practices may result in efficient utilization of energy. Therefore, the present study was undertaken with an objective to estimate the energy use pattern and energy efficiency of fully and partially mechanised rice farms in West Godavari district of Andhra Pradesh.

Materials and Methods

West Godavari district was purposively selected for the research study as it is the highest rice producing district in Andhra Pradesh with an area of 3.99 L ha during the year 2017-18. Four mandals and two villages from each mandal were selected purposively based on adoption of mechanisation i.e., fully

mechanized (if the farmer employs machinery for ploughing, transplanting and harvesting) and partially mechanized (if the farmer employs machinery only for ploughing) making a total sample of 122 rice farmers. The selected respondents were interviewed personally with the help of well-structured interview schedule and the information collected was analysed using energy input-output ratio analysis. The energy equivalents of all the inputs and outputs were shown in Table 1.

The energy input-output ratio analysis for estimating energy use pattern and energy efficiency was calculated using the following relationships (Singh, 2002; Sartori *et al.*, 2005):

$$\text{Energy productivity} = \text{Grain yield (Kg ha}^{-1}\text{)} / \text{Energy input (MJ ha}^{-1}\text{)}$$

$$\text{Specific energy} = \text{Energy input (MJ ha}^{-1}\text{)} / \text{Grainyield (Kg ha}^{-1}\text{)}$$

$$\text{Net energy} = \text{Energy output (MJ ha}^{-1}\text{)} - \text{Energy input (MJ ha}^{-1}\text{)}$$

$$\text{Energy use efficiency} = \text{Energy output (MJ ha}^{-1}\text{)} / \text{Energy input (MJ ha}^{-1}\text{)}$$

Where,

$$\text{Total energy input (MJ ha}^{-1}\text{)} = \text{Energy inputs in farm operations (MJ ha}^{-1}\text{)}$$

$$\text{Total energy output (MJ ha}^{-1}\text{)} = (\text{Yield} \times E_{\text{eqv}}) + (\text{By-product} \times E_{\text{eqv}})$$

$$E_{\text{eqv}} = \text{Energy equivalent value of main product or by-product}$$

Results and Discussion

Energy input-output ratios were estimated and the results are presented in Table 2. The results revealed that in fully mechanised

farms, the total energy input was found to be 54,719 MJ/ha which is less than that of partially mechanized farms (64,284MJ/ha). The increased input energy in partially mechanized farms increases the cost as well. The fertilizer energy accounted for the highest input energy consumption in both fully mechanized and partially mechanized farms, accounting for 36.15 per cent and 43.84 per cent of the total energy consumed respectively, followed by irrigation energy and machinery energy for fully mechanized farms and irrigation energy, human labour energy and machinery energy for partially mechanized farms. Nitrogen was the largest contributor of the fertilizer input followed by phosphorus and potassium in smallest contribution. Machinery energy in fully mechanized farms contributed 27.41 per cent

to the total input energy because ploughing, transplanting and harvesting operations were carried out by employing machinery. Whereas, it was only 10.51 per cent in case of partially mechanized farms as machinery was employed only for ploughing. Irrigation energy contributed 23.3 per cent and 19.66 per cent to the total input energy in fully and partially mechanized farms respectively as some of the farmers depending on bore wells for irrigation and electric pump sets for removing excess water from the rice fields during heavy rains. Human labour energy was higher in the partially mechanized farms because farmers mainly depend on human labour for transplanting and harvesting of rice due to lack of availability of machinery at low cost.

Table.1 Energy equivalents used in energy calculations

Energy source	Energy equivalents (MJ/Unit)
Seed (kg)	17
Men labour (hrs)	1.96
Women labour (hrs)	1.57
Machinery (hrs)	62.70
Diesel (lit)	56.31
Petrol (lit)	48.23
Pesticide (kg)	101.2
Fungicide (kg)	216
Herbicide (kg)	238
Manure (kg)	0.3
Nitrogen (kg)	60.6
Phosphorus (kg)	11.1
Potassium (kg)	6.7
Irrigation (m ³)	1.02
Paddy output (kg)	14.7
Straw (kg)	12.5

Source: Singh and Mittal (1992); Yaldiz *et al.*, (1993); Pathak and Binning (1985); Rafiee *et al.*, (2010)

Table.2 Source wise energy use pattern in rice cultivation

Source	Fully mechanised farms		Partially mechanised farms	
	Quantity	Energy (MJ/ha)	Quantity	Energy (MJ/ha)
Seeds (kg/ha)	37.5	637.5 (1.16)	75	1328 (2.04)
Human labour(hrs/ha)	102	5296 (9.67)	238.87	12403 (19.13)
Machinery (hrs/ha)	20	15002 (27.41)	9.08	6816 (10.51)
Manures(kg/ha)	2949.2	884.76 (1.61)	4156.76	1247.03 (1.92)
Fertilizers (kg/ha)	721.03	19784 (36.15)	1035.95	28425 (43.84)
Herbicides (kg/ha)	2.75	655.44 (1.19)	2.82	672.24 (1.03)
Pesticides (kg/ha)	3.30	334.29 (0.61)	5.36	543.74 (0.83)
Fungicides (kg/ha)	3.85	374.07 (0.68)	6.56	638.05 (0.98)
Irrigation (m ³ /ha)	12500	12750 (23.30)	12500	12750 (19.66)
Total energy input		54,719 (100)		64,824 (100)
Grain (kg/ha)	6806.54	100736.90 (95.02)	5834.73	86,354.23 (91.86)
Straw (kg/ha)	421.56	5,269.55 (4.97)	611.86	7,648.43 (8.14)
Total energy output		1,06,006.46 (100)		94,002 (100)
Energy productivity (Kg/MJ)	0.12		0.09	
Specific energy (MJ/Kg)	8.04		11.11	
Net energy (MJ/ha)	51,287.46		29,178	
Energy use efficiency/ Energy ratio	1.94		1.45	

Note: Values in the parenthesis indicates per cent to respective total

The net energy from the fully mechanized farms (51,287.46 MJ/ha) was higher than that from the partially mechanized farms (29,178 MJ/ha). In case of fully mechanized farms, the output energy (1,06,006 MJ/ha) was higher

than that of the partially mechanized farms (94,002 MJ/ha). This may be due to taking up of the operations like ploughing, transplanting and harvesting on time by employing machinery. The specific energy in fully

mechanized farms was found to be lowest with 8.04 MJ/kg than that of partially mechanized farms with 11.11 MJ/kg. The energy productivity was found to be highest in fully mechanized farms with 0.12 kg/MJ than that of partially mechanized farms with 0.09kg/MJ. The energy use efficiency was highest in fully mechanized farms with 1.94 than that of partially mechanized farms with 1.45.

From the study it was concluded that the total energy input was 54,719 MJ/ha, which is less than that of partially mechanized farms (64,284 MJ/ha). Energy through fertilizer consumption was found to be the dominant source of energy in both fully and partially mechanised farms, but its consumption was less in fully mechanized farms. The energy consumption (specific energy) per kg of output produced was low in fully mechanized farms. The energy productivity was highest in fully mechanized farms with 0.12kg/MJ compared to partially mechanized farms with 0.09kg/MJ. The energy use efficiency in fully mechanised farms was 1.93 compared to partially mechanised farms with 1.43. The results indicated that there is lot of scope to increase the rice productivity in partially mechanized farms by employing machinery for transplanting and harvesting operations.

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