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Energy Input-Output Analysis for Maize Production Systems in Vikarabad District of Telangana, India

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ABSTRACT

Energy analysis (input-output) of Maize production systems in Vikarabad district of Telangana State. Surveys conducted at the farms that cultivate Maize in Vikarabad district, in the 2021. Sixty farms that produce Maize were interviewed face to face**.** The results revealed that in Maize production systems total energy input was 40657.5 MJ/ha. The highest share of energy consumed was recorded for N fertilizer (73.69%) which is a nonrenewable resource. Output Energy was10892.7MJ/ha. Accordingly, energy efficiency (output input ratio) was 2.67, energy productivity calculated as 0.18 $KgMJ^{-1}$ and specific energy was observed as 5.48$MJKg^{-1}$, agrochemical energy ratio was 6.69% and energy intensiveness was 1.016. The energy use efficiency, energy productivity, specific energy, net energy of maize production systems were 2.67, 0.18 kg MJ^{-1}, 5.48 MJ kg^{-1}, and 68269.47 $MJha^{-1}$ respectively.

Key words: *Maize, Energy use, Energy productivity, Specific energy, Net energy)*

Introduction

Maize, also known as corn (*Zea mays*), is a vital cereal crop cultivated worldwide. Energy plays a pivotal role in agriculture, dating back to the era of subsistence farming. It's widely acknowledged that agricultural production correlates positively with energy input (Taheri Garavand *et al*., 2010). Reduced energy consumption in crop production translates to lower production costs, particularly in developing countries where traditional methods persist, elevating production expenses. Agriculture is a significant consumer and producer of energy. Improving energy efficiency in agricultural production involves assessing the effectiveness of methods and techniques employed. Energy usage in agriculture has surged due to population growth, dwindling arable land, and aspirations for higher living standards (Kizilaslan, 2019). The sector, like others, relies heavily on resources such as electricity, fuels, natural gas, and coke. This dependence, coupled with capital-intensive technologies, is partly fueled by relatively low energy prices compared to the resources they substitute.

Efficient energy utilization boosts production, productivity, and contributes to the economic viability and competitiveness of agriculture, especially in rural areas (Ozkan *et al*., 2007 and Singh *et al*., 2022) In Vikarabad district, agriculture dominates the economy, with 20 percent of the population engaged in agricultural and allied activities. The district boasts a gross cropped area of 2,61,360 hectares and 2,67,663 farm holdings.

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Methodology

This research was undertaken within the Vikarabad District of Telangana State, focusing on farms cultivating Maize during the year 2021. Data for the study were gathered through face-to-face surveys conducted on sixty Maize-producing farms in Vikarabad district. The selection of farms for the survey was determined using a simple random sampling method. The formula for this method is outlined as follows:

$$n = \frac{N \times 5^2 \times t^2}{(N-1)d^2 + 5^2 \times t^2}$$

Where

n = the volume of sample,

s = the standard deviation,

t = the t value of the 95% confidence interval (1.96),

N = the number of farms belonging to the sampling frame and

E = the acceptable error (5% deviation)

Finally energy use efficiency, specific energy, energy productivity and net energy were determined applying standard equations (Hatirli *et al*., 2008 and Mohammad *et al*., 2010).

Energy use efficiency= (output energy[MJha^{-1}])/(input energy [MJha^{-1}] .(1)

Specific energy= (input energy[MJha^{-1}])/(maize yield[Kgha^{1}])……(2)

Energy productivity= (Maize yield[Kgha^{-1}])/(input energy[MJha^{-11}])…… (3)

Net energy=output energy (MJha^{-1})-inputenergy(MJha^{-1})..... (4)

Energy intensiveness = Energy input MJ ha^{-1}/ Cost of cultivation Rsha^{-1}……(5)

Agrochemical energy ratio was calculated by applying Equations

Agrochemical energy ratio= input energy of agrochemicals(MJha^{-1})/total input energy(MJha^{-1})

Results and Discussion

The study unveiled that the average production cost per hectare of Maize crop amounted to Rs. 40,000. Table 2 presents a breakdown of inputs utilized and outputs in Maize production systems, along with their energy equivalents and percentages of the total energy input. Results indicated that the total energy input in Maize production systems was 40,657.5 MJ/ha. Notably, N fertilizer employed in maize production systems accounted for the highest share at 73.69% (see Fig. 1). Diesel fuel energy ranked second with 11.87% contribution to the total energy input. Seed, on the other hand, represented the smallest share of the total energy input at 0.88%. Additionally, the study observed a Maize grain yield of 7410 kg/ha, equating to a total energy equivalent of 10,892.7 MJ/ha.Table 3 presented the energy indicators for maize production systems.

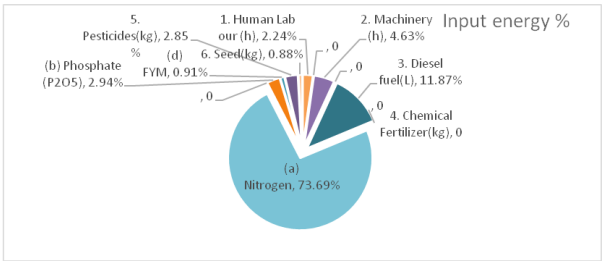

Fig. 1. The share of energy inputs for Maize production in Vikarabad District

Table 1. Energy equivalents of input and output in maize production systems.

Equipment /inputs	Unit	Energy equivalents	Reference
A. Inputs			
1. Human Labor	H	1.96	(Ozkan *et al*., 2004 and Yilmaz *et al*., 2005)
2. Machinery	h		(Erdal *et al*., 2007 and Esengun *et al*., 2007)
3. Diesel fuel	L	51.33	(Erdal *et al*., 2007 and Seyed *et al*., 2013)
4. Chemical Fertilizer	Kg		
(a) Nitrogen		66.14	(Erdal *et al*., 2007 andRafiee *et al*., 2010)
(b) Phosphate (P2O5)		12.44	(Erdal *et al*., 2007 and Rafiee *et al*., 2010)(Seyed *et al*., 2013)
5. FYM		0.3	
6. Chemical		120	(Erdal*et al*.,2007 and Ozkan*et al*., 2007)
7.Seed	Kg	14.7	(Ozkan *et al*., 2004 and Mandal *et al*., 2002)
B. Output			
1. Maize	Kg	14.7	(Ozkan *et al*., 2004 and Mandal *et al*., 2002)

Table 2. Energy equivalents of input and output in maize production systems in Vikarabad district

Quantity (input and output)	Quantity per unit area (ha)	Total energy equivalents ($MJha^{1-}$)	Percentage of total energy (%)
A. Inputs			
1. Human Lab our (h)	464.36	910.14	2.24
2. Machinery (h)	30	1881	4.63
3. Diesel fuel(L)	94	4825.02	11.87
4. Chemical Fertilizer(kg)			
(a) Nitrogen	453	29961.4	73.69
(b) Phosphate (P_2O_5)	96	1194.24	2.94
5. FYM	1235	370.5	0.91
6. Pesticides(kg)	9.65	1158	2.85
7. Seed(kg)	24.3	357.21	0.88
Total energy input(MJ)		40657.5	100
B. Output			
1. Maize	7410	108927	100
Total energy output(MJ)		10892.7	100

Notably, the energy efficiency, represented by the output-input ratio, was calculated at 2.67. The lower energy use efficiency observed in maize production systems can be attributed to the elevated energy inputs, particularly the consumption of N fertilzer

In maize production systems, the energy productivity, denoting the grain yield per energy input, was measured at 0.18 kg MJ^{-1}, while the specific energy, indicating the input energy required per unit of grain yield, stood at 5.48 MJ kg^{-1}. Put differently, for every MJ of input energy, 0.18 kg of maize grain was produced, or conversely, 5.48 MJ of energy was expended to yield one kilogram of grain. Furthermore, the system net energy, calculated as the output minus input, amounted to 68,269.47 MJ ha^{-1}. The agrochemical energy ratio accounted for 6.69% of the input energy in maize production systems. Additionally, the energy intensiveness, indicating the amount of energy produced per rupee spent, was computed at 1.016 MJ Rs^{-1}, signifying that for each rupee invested, 1.016 MJ of energy could be generated.

Table 3. Indicators of energy use in Maize production systems.

Indicators	Unit	Quantity
Inputs energy	$MJha^{-1}$	40657.5
Output energy	$MJha^{-1}$	108927
Maize yield	$Kgha^{-1}$	7410
Energy use efficiency		2.67
Specific energy	$MJkg^{-1}$	5.48
Energy productivity	$KgMJ^{-1}$	0.18
Agrochemical Energy Ratio	%	6.69
Net energy	$MJha^{-1}$	68269.47
Energy intensiveness	$MJRs^{-1}$	1.016

Conclusion

In this study the input and output energy for maize production in Vikarabad District agriculture systems in of Telangana State have been investigated. That Following conclusions are drawn;

1. Total energy input and output in maize production systems were 40657.5and 108927$MJha^{-1}$.
2. That the highest share, of input energy was reported for nitrogen fertilizer, and diesel fuel, (73.69, and 11.87%) respectively.
3. The energy use efficiency, energy productivity, specific energy, net energy of maize production systems were 2.67, 0.18 kg MJ^{-1}, 5.48 MJ kg^{-1}, and 68269.47 $MJha^{-1}$ respectively. The energy intensiveness was $1.016MJRs^{-1}$

Conflict of Interests: None

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