An Analysis of Energy Input and Output dynamics in Redgram production of Vikarabad District, Telangana

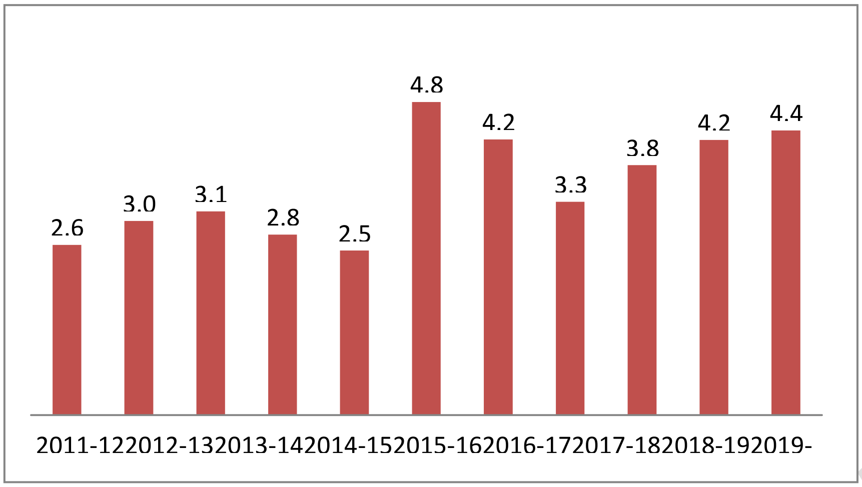
ABSTRACT

Energy analysis (input-output) of Redgram production systems in Vikarabad district of Telangana State. Surveys conducted at the farms that cultivate Redgram in Vikarabad district, in the 2021. Sixty farms that produce Redgram were interviewed face to face**.** The results revealed that in Redgram production systems total energy input was 19289.61MJ/ha. The highest share of energy consumed was recorded for N fertilizer (78.29%) which is a nonrenewable resource. Output Energy was 11025 MJ/ha. Accordingly, energy efficiency(output input ratio) was 3.11, energy productivity calculated as 0.021 $KgMJ^{-1}$ and specific energy was observed as 45.7 $MJKg^{-1}$, agrochemical energy ratio was 0.82 % and energy intensiveness was 1.14.

Keywords: (Redgram, energy use, energy productivity, specific energy, net energy)

1. INTRODUCTION

Redgram is commonly known as Tur or Arhar in India and is the second important pulse crop in the country after gram (chana). The ability of redgram to produce high economic yields under soil moisture deficit makes it an important crop in rainfed and dry land agriculture. World major redgram producing countries are India (38.90 lakh tonnes), Malawi (4.34 lakh tonnes), Myanmar (3.47 lakh tonnes), Tanzania (0.90 lakh tonnes) and Haiti (0.44 lakh tonnes).



SOURCE: DIRECTORATE OF ECONOMICS AND STATISTICS (DES). PRODUCTION OF REDGRAM IN INDIA (IN MILLION TONNES

Fig 1 Major Redgram producing countries (2021-22)

Table1:StatewiseareaunderRedgramin India

State	2020-21		2021-22	
	Area (lakh ha)	Area (lakh acres)	Area (lakh ha)	Area (lakh acres)
Karnataka	12.81	31.64	14.47	35.77
Maharashtra	12.47	30.81	13.24	32.72
Madhya Pradesh	4.12	10.18	4.28	10.58
Uttar Pradesh	3.51	8.68	3.54	8.75
Telangana	4.36	10.76	3.09	7.65
Others	10.92	26.98	11.39	28.15
All India	48.18	119.05	50.02	123.61
Source: www.agricoop.nic.in				

Table2:Districtwise areaunderRedgramin Telangana

District	2020-21		2021-22	
	Area (ha)	Area (acres)	Area (ha)	Area (acres)
Vikarabad	74725	184649	71606	176943
Narayanpet	55925	138193	45072	111374
Sanga Reddy	43712	108014	36439	90043
Adilabad	25044	61885	24477	60483
Mahabubnagar	28939	71509	10917	26976
Yadadri	18312	45250	9258	22877
Kamareddy	9829	24287	7611	18806
Others	179070	442490	104067	257155
Telangana State	435555	1076277	309446	764657

Source:www.agri.telangana.gov.in

Area under redgram reported during 2021-22 was 50.02 lakh ha (123.61 lakh acres) as against 48.18 lakh ha (119.05 lakh acres) during the same period in 2020-21. In India, major redgram producing states are Maharashtra 14.47 lakh ha (35.77 lakh acres), Karnataka 13.24 lakh ha (32.72 lakh acres), Madhya Pradesh 4.28 lakh ha (10.58 lakh acres), Telangana 3.09 lakh ha (7.65 lakh acres) and Uttar Pradesh 3.54 lakh ha (8.75 lakh acres). In Telangana major redgram growing districts are Vikarabad 71606 ha (176943 acres), Narayanpet 45072 ha (111374 acres), Sangareddy 36439 ha (90043 acres), Adilabad 24477 ha (60483 acres) Mahabubnagar 10917 ha (26976 acres), Yadadri 9258 ha (22877 acres) and Kamareddy 7611 lakh ha (18806 acres).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 (TaheriGaravand*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.

2. MATERIAL AND METHODS

This research was undertaken within the Vikarabad District of Telangana State, focusing on farms cultivating Redgram during the year 2021. Data for the study were gathered through face-to-face surveys conducted on sixty Redgram-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:

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

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[$MJha^{-1}$])/(Redgram yield[$Kgha^{1}$])………(2)

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

Net energy=outputenergy($MJha^{-1}$)-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($MJha^{-1}$).

Table 3: Energy equivalents of input and output in Redgram 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.*,2007and Seyed *et al.*, 2013)
4. Chemical Fertilizer	kg		
(a) Nitrogen		66.14	(Erdal *et al.*,2007 and Rafiee *et al.*,2010)
(b) Phosphate (P2O5)		12.44	(Erdal *et al.*,2007 and Rafiee *et al.*,2010)
5. FYM		0.3	(Seyed *et al.*, 2013)
6. Chemical		120	(Erdal *et al.*,2007 and Ozkan *et al.*, 2007)

7.Seed	Kg	14.7	(Ozkan *et al.*,2004 andMandal *et al.*,2002)
B. Output			
1. Redgram	Kg	12.5	(Adarsh Kumar *et al.*, 2021)

3. RESULTS AND DISCUSSION

The study unveiled that the average production cost per hectare of Redgram crop amounted to Rs. 30,000/-. Table 2 presents a breakdown of inputs utilized and outputs in Redgram production systems, along with their energy equivalents and percentages of the total energy input. Results indicated that the total energy input in Redgram production systems was 34299.54 MJ/ha. Notably, N fertilizer employed in Redgram production systems accounted for the highest share at 78.29 % (see Fig. 2). Diesel fuel energy ranked second with 12.37 % contribution to the total energy input. Seed, on the other hand, represented the smallest share of the total energy input at 0.21 %. Additionally, the study observed a Redgram yield of 750 kg/ha, equating to a total energy equivalent of 34299.54 MJ/ha. Table 2 presented the energy indicators for Redgram production systems. Notably, the energy efficiency, represented by the output-input ratio, was calculated at 3.11. The lower energy use efficiency observed in Redgram production systems can be attributed to the elevated energy inputs, particularly the consumption of N fertilizer

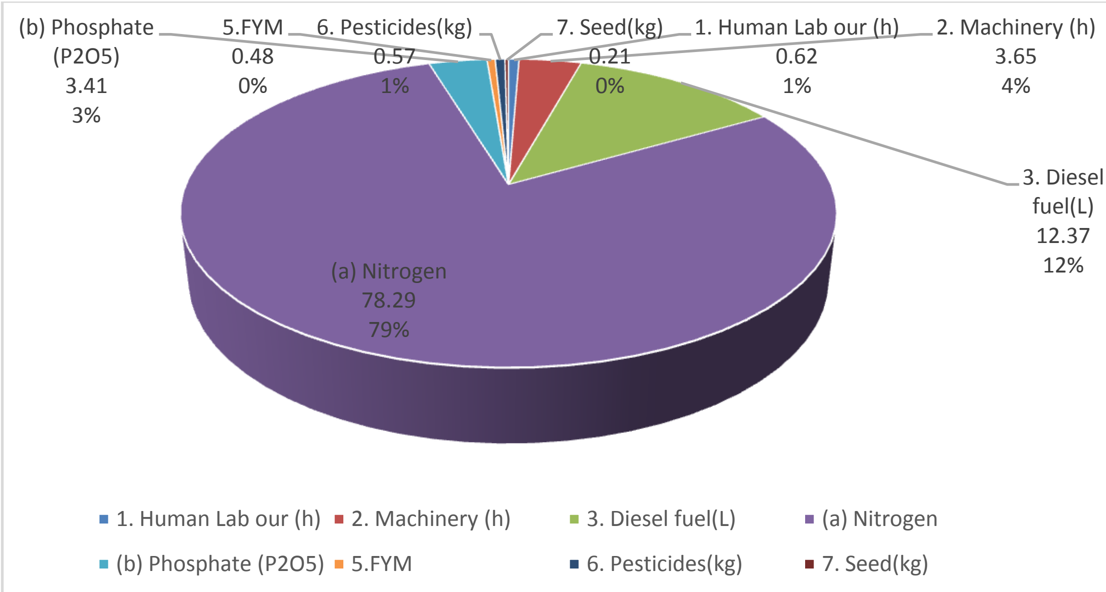


Fig 2. The share of energy inputs for Redgram production in Vikarabad District

Table 4: Energy equivalents of input and output in Redgram 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)	110	215.60	0.62
2. Machinery (h)	20	1254.00	3.65
3. Diesel fuel(L)	75.47	4249.72	12.37
4.Chemical Fertilizer(kg)			
(a) Nitrogen	406	26852.84	78.29
(b) Phosphate (P_2O_5)	94	1169.36	3.41
5.FYM	550	165	0.48
6. Pesticides(kg)	1.65	198.00	0.57
7. Seed(kg)	5	73.50	0.21
Total energy input(MJ)		34299.54	100
B. Output			
1. Redgram	750	11025	100
Total energy output(MJ)		11025	100

In Redgram production systems, the energy productivity, denoting the Redgram yield per energy input, was measured at 0.021 kg MJ^{-1}, while the specific energy, indicating the input energy required per unit of grain yield, stood at 45.7 MJ kg^{-1}. Put differently, for every MJ of input energy, 0.15 kg of Redgram grain was produced, or conversely, 45.7 MJ of energy was expended to yield one kilogram of grain. Furthermore, the system net energy, calculated as the output minus input, amounted to 23274.54 MJ ha^{-1}. The agrochemical energy ratio accounted for 0.44 % of the input energy in Redgram production systems. Additionally, the energy intensiveness, indicating the amount of energy produced per rupee spent, was computed at 0.82 MJ Rs^{-1}, signifying that for each rupee invested, 0.82 MJ of energy could be generated.

Table 5 : Indicators of energy use in Redgram production systems.

Indicators	**Unit**	**Quantity**
Inputs energy	$MJha^{-1}$	34299.54
Output energy	$MJha^{-1}$	11025
Redgram yield	$Kgha^{-1}$	750
Energy use efficiency		3.11
Specific energy	$MJkg^{-1}$	45.7
Energy productivity	$KgMJ^{-1}$	0.021
Agrochemical Energy Ratio	%	0.82
Net energy	$MJha^{-1}$	23274.54
Energy intensiveness	$MJRs^{-1}$	1.14

4. CONCLUSION

In this study the input and output energy for Redgram 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 Redgram production systems were 34299.54 and 11025 $MJha^{-1}$

2. That the highest share, of input energy was reported for nitrogen fertilizer, and diesel fuel, (78.29 , and 12.37 %) respectively.

3. The energy use efficiency, energy productivity, specific energy, net energy of Redgram production systems were 3.11 , 0.021 kg MJ^{-1}, 45.7 MJ kg^{-1}, and 23274.54 $MJha^{-1}$ respectively. The energy intensiveness was 1.14 $MJRs^{-1}$

REFERENCES

1 Demircan V, Ekinci Keenerm D, Akbolat , Ekinci.. A case study from Isparta province. Energy Convers Manage. *Energy and economic analysis of sweet cherry production in Turkey*.2006:47(1): 1761–1769.

2 ErdalG,Esengun K,ErdalGunduz O Energy use and economical analysis ofsugarbeetproductioninTokatprovinceofTurkey.*Energy*. 2007;32:35–41.

3 Esengun K, Gunduz O, Erdal G. Input– output energy analysis in dry apricot production of Turkey. *Energy Convers Manage*.2007; 48: 592– 598.

4 Seyed Mohammad Hossein Tabatabaie, Shahin Rafiee, Alireza Keyhani, Mohammad Davoud Heidari Energy use pattern and sensitivity analysis of energy inputs and input costs for pear production in Iran. *Renewable energy*. 2013; 51:7-12.

5. HatirliSA, Ozkan B, Fert C.Energy inputs and crop yield relationship in greenhouse tomato production. *Renew Energy*. 2008;31: 427- 438.

6. KhanS,Khan MA,HanjraJ,Mu.Pathways to reduce the environmental footprintsof water and energy input in food production.*Foodpolicy*. 2009;34:141-149.

7. Kizilaslan H. Input–output energy analysis of cherries production in Tokat Province of Turkey. *Applied Energy*.2009; 86: 1354–1358.

8 Mandal KG, Saha KP, Ghosh PK, Hati KM, Bandyopadhyay KK. Bioenergy and economic analysis of soybean-based crop production systems in central India. *Biomass Bioenergy*.2002;23(5): 337-345.

9. Mohammad A,RafieeS,Mohtasebi SS, Rafiee, H,(2010) Energy inputs–yield relationship and cost analysis of kiwifruit production in Iran. *Renewable Energy*. 2010; 35: 1071-1075.

10. Ozkan B, AkcaozH,Fert C,. Energy input–output analysis in Turkish agriculture. *Renewable Energy*. 2004; 29: 39–51.

11. Ozkan B,FertC,Karadeniz CF, Energy and cost analysis for greenhouse and open file grape production and open- field grape production. *Energy*.2004; 32: 1– 4.

12. Rafiee S, Mousavi SH, Mohammadi A.Modelling and sensitivity analysis of energy inputs for apple production in Iran. *Energy*.2010;35(8): 3301-6.

13. Adarsh Kumar , K.S. Rana, Anil K. Choudhary , R.S. Bana , V.K. Sharma , Shiv Prasad Gaurendra Gupta , Mukesh Choudhary , Amaresh Pradhan , Sudhir K. Rajpoot, Abhishek Kumar , Amit Kumar , Vishal Tyagi.(2021*)* Energy budgeting and carbon footprints of zero-tilled pigeonpea wheat cropping system under sole or dual cropbasis residuemulching and Zn- fertilization in a semi-arid agro-ecology. Energy.2021;231:120862

14 Streimikiene D, Klevas V, Bubeliene J. Use of EU structural funds for sustainable energy development in new EU member states. *Renew Sustain Energy Rev*. 2007;116: 1167–87.

15.TaheriGaravanA, Asakereh A, Haghani K. Energy elevation and economic analysis of canola production in Iran a case study: Mazandaran province. *International journal of environmental sciences*. 2010; 1(2): 236- 243.

16.Yilmaz I, AkcaozH, Ozkan B. An analysis of energy use and input costs for Redgram production in Turkey. *Renewable Energy*. 2005;30(2): 145–55.

17. Singh JM.(2002) On farm energy use pattern in different cropping systems in Haryana,
India. Germany: Int Inst of Management, University of Flensburg, Sustainable Energy Systemsand Management, Master of Science Thesis, Germany.