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The analysis of energy audit for sunflower production in Northern Transition Zone of Karnataka, India

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ABSTRACT : Energy plays a major role in agricultural production of any country. The aim of this case study was to create awareness about energy usage for the sunflower production per hectare in Northern Transition Zone of Karnataka, India. The data were collected from the 40 randomly selected farmers using face to face questionnaire method, and farmers having more or less homogeneous red sandy loam type soil. The results showed that energy ratio, energy productivity, specific energy and net energy gain for sunflower were 2.312, 0.09 kg MJ^{-1}, 10.81 MJ kg^{-1} and 28118.21 MJ ha^{-1}. The study revealed that sunflower production consumed a total 21427.72 MJ ha^{-1} out of this, fertilizer energy consumption was 40.96 per cent followed by electricity (30.78%) and diesel fuel (11.35%). The direct and indirect type energy contribution was 47.06 per cent and 52.94 per cent, as well as renewable and non-renewable energy contribution was 12.01per cent and 87.99 per cent, respectively.

KEY WORDS : Energy ratio, Specific energy, Sunflower production, Input output ratio

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Sunflower is originated in Southern United States and Mexico from where it was introduced into Europe and later into former USSR. Sunflower (*Helianthus annuus* L.) is an important oilseed crop in India popularly known as "Surajmukhi". The name "Helianthus" is derived from 'Helios' meaning 'sun' and 'anthos' meaning 'flower'. It is one of the fastest growing oilseed crops in India. In early 1970s, only about 0.1 million hectares were under sunflower cultivation, however by 2009-10, it had gone up to 1.48 million hectares of area with a production of 0.85 million tonnes in the year 2009-2010. Karnataka stands first place in both production and area of cultivation *i.e.* 35.76 per cent (0.30 million tonnes) and 53.79 per cent (0.79 million hectors) during the year 2009-2010 in the country (Source: Ministry of agriculture, Govt. of India). Sunflower is grown also in summer season under irrigation farming system. The present study is to create clear idea of energy contribution by each source for sunflower production under summer season in Northern Transition Zone (Zone 8), Karnataka, India. Energy auditing is most important consideration in agriculture, this were in different forms, such as mechanical (tractor, bullocks, human, etc), chemical fertilizer, pesticides, electrical, etc. Lot of studies have been done to evaluate the energy consumption by different forms. Uzunoz *et al.*(2008) concluded the energy requirement for sunflower production was 18931.09 MJ ha^{-1} in Turkey. In this study, fertilizer was the highest energy contributing input *i.e.* 51.28 per cent, followed by diesel fuel *i.e.* 28.55 per cent. Kallivroussis *et al.*(2002) revealed that the total energy consumption in sunflower production in Greece was 10.49 GJ ha^{-1}, with fertilizer being the major energy input. Energy ratio and net energy gain were 4.5 and 36.87 GJ ha^{-1}, respectively. The main objectives of this study are :

–To find the direct and indirect source of energy contribution in sunflower cultivation, to find the renewable and non-renewable source of energy contribution in sunflower cultivation.

METHODOLOGY

The data were collected from the 40 randomly selected farmers using face to face questionnaire method, having homogeneous red sandy loam type soil. Twenty villages were chosen to represent the status of sunflower farm activity around Hirekerur Taluk, Karnataka, India in the period of 2011-12. The data collection involved the various operational energy input and output. The input energy separated into direct and indirect and renewable and non-renewable forms (Kallivroussis *et al*., 2002). The direct energy consist of diesel, human power, bullocks, electricity while the indirect energy consist of seed, fertilizer, FYM, chemical, machinery and equipment (mould board plough, tractor, cultivator, blade harrow, etc), threshers, pesticides (superior) (Singh *et al*., 2007). On the other hand renewable energy consisted of human labour, FYM and seeds, and non-renewable energy included machinery, diesel, chemical fertilizer and electricity. The amount of each input was calculated and multiplies with its energy equivalents in order to compare with output energy. And finally this energy contribution was converted in terms of MJ ha^{-1} by using standard methods. The energy equivalents used for present study are shown in the Table A.

The calculation of energy input and output equivalents, to assess the different energy measures for sunflower production such as energy use efficiency, energy productivity, specific energy (energy intensity) and net energy were calculated by following formula(Mousavi- Avval *et al.*, 2011) shown here:

Table A : Equivalents for various sources of energy

Input	Units	Energy equivalent(MJ/unit)
1.Human labour		
Man	Man-hour	1.96
Woman	Woman-hour	1.57
2.Bullocks(medium)	Pair-hour	10.10
3.Diesel	litre	56.31
4.Electricity	kW-hour	11.93
5.Machinery		
Prime mowers and other than electric motors	kg	68.40
Electric motors	kg	64.80
6.Chemical Fertilizers		
Nitrogen	Kg	60.60
P_2O_5	kg	11.10
K_2O	kg	6.70
8.FYM	kg	0.30
9.Chemicals(superior)	kg	120.00
10.Seed(oil seeds)	kg	25.00

Source: (Singh and Mittal, 1992)

Table B: Contribution of direct and indirect energy sources

Inputs	$MJha^{-1}$
Direct energy sources	
Human labour**	550.52
Bullocks**	507.60
Diesel fuel*	2431.09
Electricity*	6592.03
Indirect energy sources	
Seeds**	91.71
FYM**	1423.17
Plough*	44.92
Indigenous plough*	14.53
Tractor*	228.86
Cultivator(rigid 9 tines)*	14.52
Blade harrow/bakhar(tractor drawn)*	582.99
Hoeing harrow*	11.00
Chemical fertilizer*	8773.17
Chemicals(superior)*	16.71
Thresher*	140.90

** Renewable energy sources, * Non-renewable energy sources

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

$$\text{Energy productivity} = \frac{\text{Soybean yield (kg ha}^{-1}\text{)}}{\text{Energy input (MJ ha}^{-1}\text{)}}$$

$$\text{Specific energy} = \frac{\text{Energy input (MJ ha}^{-1}\text{)}}{\text{Soybean yield (kg ha}^{-1}\text{)}}$$

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

The amount of inputs used in sunflower production is presented as direct and indirect forms of energy and renewable and non renewable energy forms shown in Table B.

RESULTS AND DISCUSSION

In the study area, the use of human power were found to be 280.88 h ha^{-1}, which included usage of human in all activity to cultivate sunflower, similarly the bullocks user for 50.26 h ha^{-1}. Farms with low level of technology used the chemicals, chemical fertilizers, farmyard manure and surface irrigation. The energy used for pumping the water was met out by electric motor. The energy consumption for chemical fertilizer was more compared to other inputs because the application of the fertilizer twice at time of sowing and 30-40 days after sowing *i.e.* totally 131.26 kg ha^{-1}. This was happened due to traditional practice and unknowing of nutritional requirements of field. The investment of the energy for this can be managed properly by knowing nutritional demand for particular field. The next most energy used was electricity which was used for pumping the water for surface irrigation to irrigate 4 to 5 times *i.e.* 552.56 kW hr ha^{-1}. This can be reduced by adopting new technologies of irrigation methods and which also saves the irrigation water. The share of direct and indirect energy used for sunflower was 47.06 per cent and 52.94 per cent of the total input energy. Similarly, renewable and non-renewable energy spent about 12.01 per cent and 87.99 per cent, respectively; these are shown in Table 1.

From the Fig. 1, the total human labour (man hour and woman hour) activity involving primary and secondary tillage operation (ploughing, harrowing), FYM broadcasting, sowing, weeding, spraying, harvesting and threshing was about 2.57 per cent. The bullocks (pair hour) used for sowing and inter cultivation operation contributed 2.37 per cent energy. The diesel fuel used at the time of primary tillage operation and threshing, this was about 11.35 per cent. The farm machinery equipment involves the energy from tractor, plough, cultivator (rigid 9 tines), harrow and indigenous (balaram) plough. Spraying of the chemicals (superior) was done by using the manual operated knapsack sprayer. The harvesting was done by manually using locally available sickle, this accounted 31.08 h ha^{-1}. Threshing was carried out by self-propelled 5-7.5HP diesel engine operated multi crop thresher.

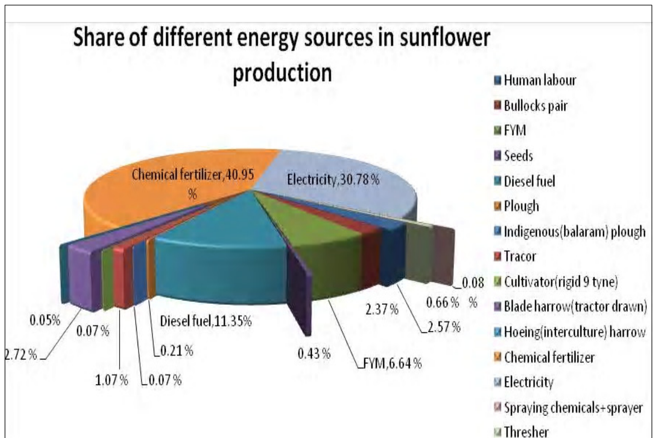

Table 1: Per cent share of different forms of energy in the sunflwer production

Table 1 : Energy use status of sunflower

Particulars	Energy for sunflower
Direct energy use	10084.23 MJ ha^{-1} (47.06%)
Indirect energy use	11342.49 MJ ha^{-1} (52.94 %)
Renewable energy use	2572.99 MJ ha^{-1} (12.01%)
Non-renewable energy use	18853.73 MJ ha^{-1} (87.99%)
Total input energy	21427.72 MJ ha^{-1}
Total output energy	49544.93 MJ ha^{-1}
Energy ratio or Energy use efficiency	2.31
Energy productivity	0.09 kg MJ^{-1}
Specific energy	10.81 MJ kg^{-1}
Net energy gain	28118.21 MJ ha^{-1}

Note: The values in the brackets showing the percentage of the total input

Conclusion :

The results conclude from study that the direct and indirect source of energy contribution was 10084.23 MJ ha^{-1} (47.06%) and 11342.49 MJ ha^{-1} (52.94 %) and the renewable and non-renewable source of energy contribution was 2572.99 MJ ha^{-1} (12.01%) and 18853.73 MJ ha^{-1} (87.99%), respectively. Major energy contribution was from chemical fertilizer, electricity and diesel fuel *i.e.* 40.96 per cent, 30.78 per cent and 11.35 per cent, out of total energy input 21427.72MJ ha^{-1}. These inputs contributed to the total energy used at more than 80 per cent. The chemical fertilizer application was carried by manual broadcasting method and without knowledge of nutritional demand to the field. This is to be managed properly by providing those on need basis of the field, in this way we can reduce the chemical fertilizer energy consumption. In the present case, surface flooding irrigation method was followed to irrigate the crop, this has lower water use efficiency. This can be improvined by switching to new technique like alternate furrow irrigation method or drip irrigation method this will save the water as well as soil health favourable for plant growth (Bhatnagar and Panesar, 1989). In the same way the fuel energy can improve by right combination of tillage practices such as rotavator cum seed drill or zero-till-drill (Singh and Mittal, 1992).

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