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Original Research Paper

Energy use pattern in rose onion (*Allium cepa* L.) cultivation

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ABSTRACT

A study was conducted to analyse the energy use pattern for cultivation and on farm processing of rose onion (*Allium cepa* L.). The energy auditing data was collected by stratified random sampling method using a face-to-face interaction at Sadali (Hobli), Sidlaghatta, Chikkaballapur, Karnataka. In this region, the energy utilized for different package of practices followed for rose onion cultivation by conventional practice are land preparation (5-tyne cultivator, 9-tyne cultivator and rotovator), sowing (broadcasting), thinning (manual), manure & fertilizer application (manual), plant protection {weeding (manual and chemical spray), chemical spraying (battery operated sprayer)}, irrigation (micro-irrigation), harvesting (manual) and detopping (manual). The energy use pattern for the above-mentioned various package of practices were found to be 4,207.95±37.21, 664.66±17.68, 53.31±2.68, 22,522.92±385.07, 2,534.40±155.55, 14,980.51±229.49, 807.74±20.80 and 1,571.75±42.77 MJ ha^{-1}, respectively. The input energy, output energy and energy ratio were calculated as 47,343.23±484.65, 38,131.12±462.48 MJ ha^{-1} and 0.81±0.01, respectively. The energy intensive operation identified was manure and fertilizer application (fertilizer 46.80%; men 0.77%) both indirect and direct energy sources, followed by irrigation (electricity 31.09%; men 0.55%), land preparation (diesel 8.33%) and pesticide application (pesticide 4.53%). It is concluded that the fertilizer, electricity and diesel utilised in rose onion cultivation needs to be optimally minimised through management practices.

Keywords: Energy auditing, energy management, energy use pattern, onion cultivation, rose onion

INTRODUCTION

Energy is one of the basic inputs for national development process and provides the major vital services that improve human condition such as fuel for cooking, light for living, motive power for transport and electricity for modern communication. Energy input–output analysis in production and post–production agriculture is very important for developing efficient and sustainable crop production systems. Crop production is highly dependent on varieties, chemicals, fertilizers, mechanization and other energy inputs, which would be further affected by level of technology and agro-climatic zone.

The precise application of input energy helps directly to get more production and productivity, which inturn helps to attain profitability and competitiveness for agricultural sustainability (Singh et al., 2002). The energy use pattern varies with the geographical location, application of input energy (direct energy - men, women, tractor, diesel and electricity and indirect energy - seed, fertilizer, pesticide and machinery) by farmers. The application of input energy by farmers for crop production is more than the required or sometimes even less than the required rate. Introduction of good agricultural practices, machinery and adoption of skilled labour will reduce energy input and also may reduce the use of labour and time in crop production (Karale et al., 2008).

Onion (*Allium cepa* L.) has been valued as a food and a medicinal plant since ancient times. It is widely cultivated after tomato and the crop is known to most cultures and consumed worldwide. It is a short duration horticultural crop grown at low latitudes. It is commonly known as "Queen of the kitchen," due to its highly valued flavour, aroma, and unique taste, and the medicinal properties of its flavour compounds. The major onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Bihar, Rajasthan, Andhra Pradesh, Haryana, West Bengal, Gujarat and Uttar Pradesh, accounting almost 90% of the total onion production of the country. In India, the area, production and productivity of onion was reported to be 19.14 lakh ha, 312.72 lakh MT and 16.34 MT ha^{-1}, respectively, similarly, in Karnataka, it was reported to be 2.31 lakh ha, 27.79 lakh MT and 11.99

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MT ha^{-1}, respectively (www.indiastat.com, 2021-22). Karnataka is one of the leading states in the cultivation of onion next to Maharashtra and Madhya Pradesh occupying 14% of area and 10% of the total production of onion in the country.

Many researchers have studied energy use pattern and estimated its economics for different crop production systems *viz.*, wheat, maize, soybean, (Sartori et al., 2005), tomato (Esengun et al., 2007), soybean (Mandal et al., 2002); tomato (Hartirli et al., 2006), green gram (Tripathi et al., 2013) cultivations and chickpea in Vertisols of semi-arid tropics (Patil et al., 2014). Ozkan et al. (2004) studied about greenhouse vegetable production in Turkey. Energy application pattern for production of pulses in Iran was done by Koocheki et al. (2011). The present study discusses the energy use pattern for production of rose onion.

MATERIALS AND METHODS

Rose onion

Rose onion is one among the types of onion, popularly known as Bangalore Rose Onion and locally called as *'Gulabi Eerulli'*. This is almost exclusively grown for the export market and has got Geographical Indication Tag during 2014-15. It is mainly grown in Chikkaballapur, Bengaluru Rural, Bengaluru Urban and Kolar districts of Karnataka State. The soil and climate conditions of deep fertile mekklu soil and sand mix of red soil with good infiltration, soil pH ranging between 6.5 to 7, relative humidity (70-75%) and average temperature (25°-35°C) of these areas, are ideally suitable for this category of onions. The bulbs are smaller in size (diameter : 25-35 mm) when compared to common onion (40-60 mm). The two varieties grown by farmers are Agri found Rose and Arka Bindu (www.apeda.in.). This is also called as small common onion and also known for its high pungency. These onions also have higher levels of protein, phosphorus, iron and carotene. About 90% of the production is exported to Malaysia, Thailand, Singapore and Taiwan. It is used in seasoning, pickling and in the form of dehydrated powder in these South Asian Countries and mainly preferred for its high pungency.

Location

The study was conducted Sadali village in Sidlaghatta Taluk (13.39° N and 77.86° E) of Karnataka state,

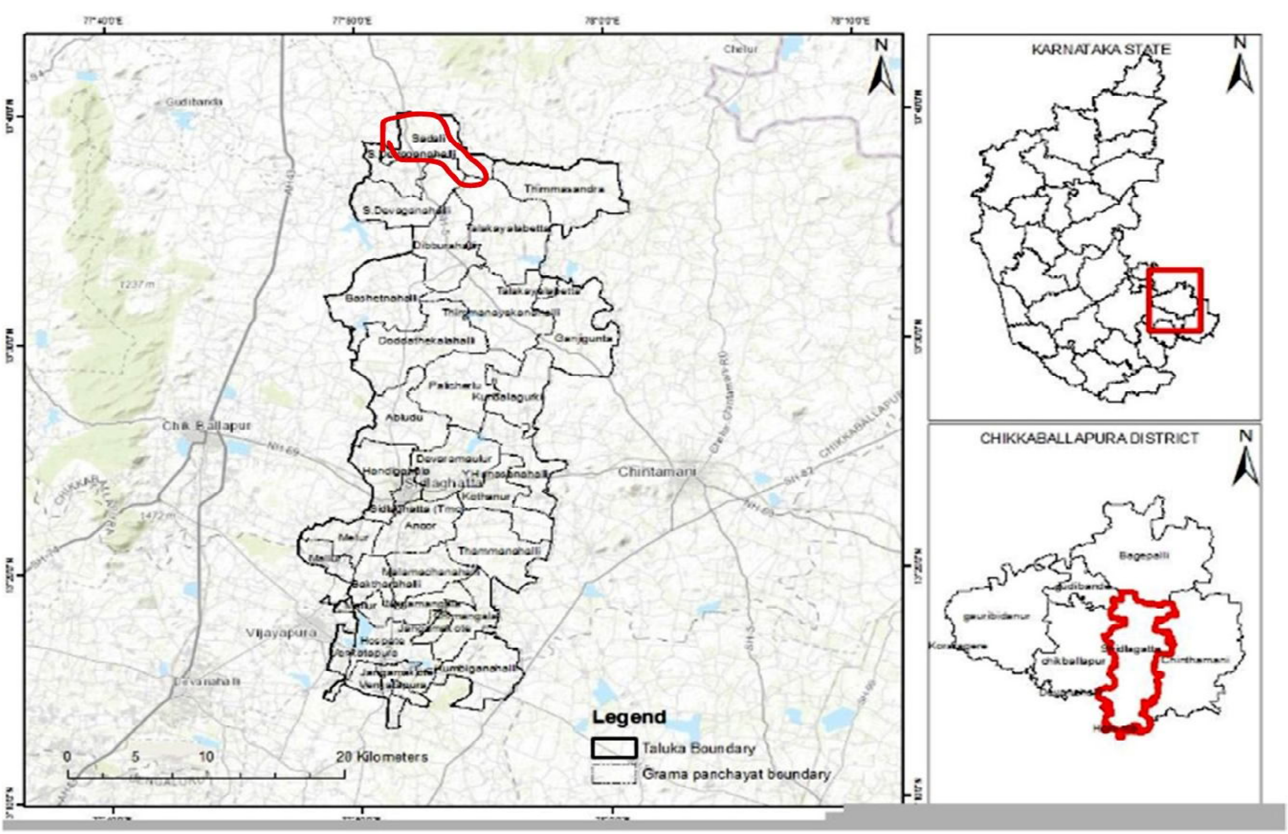

Fig 1 : Geographical map of the study area

India located at an elevation of 878 m. The soil type of Sidlaghatta Taluk is red loamy, red sandy and red soil, respectively.

Unit operations in rose onion cultivation

The various unit operations followed in cultivation and production practices of onion are land preparation (5-tyne cultivator, 9-tyne cultivator and rotovator), direct seed sowing (broadcasting), irrigation (micro-irrigation), thinning (manual), weeding (manual and chemical spray), chemical spraying (battery operated sprayer), fertilizer application (manual), harvesting (manual) and detopping (manual). The sources of energy inputs for onion production were human labour, machinery, diesel, seed, chemicals, fertilizers, farmyard manure, water and output was onion bulbs. Data for these parameters was collected by stratified random sampling method using a face-to-face interaction from 50 onion growing farmers.

The energy coefficients were used to estimate the energy requirement. The human energy was calculated by multiplying the number of man-hours (h ha^{-1}) with energy coefficient (Singh & Mittal, 1992; Kitani, 1999). Other inputs energies like diesel, seed and fertilizers used in onion production were estimated by multiplying the amount of material used in the farms with their respective energy coefficients. Electrical energy is used to lift the water and micro irrigation is adopted for irrigation. The output energy was calculated by multiplying the onion yield (kg ha^{-1}) with energy coefficients (MJ ha^{-1}).

RESULTS AND DISCUSSION

The results were analysed source-wise as well as operation-wise (Table 1). In case of operation-wise input energy, the highest energy source was observed to be manure & fertilizer application (22,522.92 MJ ha^{-1}) followed by irrigation (14,980.51 MJ ha^{-1}), land preparation (4,207.95 MJ ha^{-1}), plant protection (2,534.40 MJ ha-1), detopping (1,571.75 MJ ha^{-1}), harvesting (807.74 MJ ha^{-1}), sowing (664.66 MJ ha^{-1}) and thinning (53.31 MJ ha^{-1}). The source-wise percentage of input energy is presented in Table. 2. It was observed that the highest input energy was observed in fertilizer (46.80%) followed by electricity (31.18%) utilized for irrigation, diesel (9.55%) utilized for land preparation and women (5.30%). The results are in accordance with the findings of Chaudhary et al., (2014).

Total men energy was observed to be 2.01% comprising 0.08%, 0.05%, 0.77%, 0.05%, 0.55% and 0.51% for land preparation, sowing, fertilizer application, plant protection, irrigation, and detopping operations, respectively, indicating that highest men energy was utilised for fertilizer application followed by irrigation and detopping. Men energy utilized for land preparation, sowing and plant protection were observed to be very minimum. The different sources from women were observed to be 5.30% comprising 0.11%, 0.67%, 1.71% and 2.81% for thinning, plant protection, harvesting and detopping operations, respectively, depicting that highest women energy was utilised for detopping followed by harvesting and weeding. Tractor was used only for land preparation

Table 1 : Operation-wise and source-wise energy inputs for rose onion cultivation

Unit operation	Direct energy					Indirect energy				Total Energy (MJ ha^{-1})
	Men (MJ ha^{-1})	Women (MJ ha^{-1})	Tractor (MJ ha^{-1})	Diesel (MJ ha^{-1})	Electricity (MJ ha^{-1})	Seed (MJ ha^{-1})	Fertilizer (MJ ha^{-1})	Pesticide (MJ ha^{-1})	Machinery (MJ ha^{-1})	
Land preparation	37.34	0.00	225.72	3942.52	0.00	0.00	0.00	0.00	2.37	4207.95
Sowing	23.22	0.00	41.80	576.55	0.00	22.04	0.00	0.00	1.04	664.66
Thinning	0.00	53.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.31
Manure & fertilizer	365.42	0.00	0.00	0.00	0.00	0.00	22157.50	0.00	0.00	22522.92
Plant protection	24.94	317.42	0.00	0.00	44.83	0.00	0.00	2146.72	0.50	2534.40
Irrigation	261.91	0.00	0.00	0.00	14718.60	0.00	0.00	0.00	0.00	14980.51
Harvesting	0.00	807.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	807.74
Detopping	240.64	1331.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1571.75
Total energy	953.48	2509.57	267.52	4519.07	14763.43	22.04	22157.50	2146.72	3.91	47343.23

utilising 0.57% of energy and the energy utilised by land preparation implements was very minimal.

Data presented in Table 2 and Fig. 2 indicated that the operations *viz.*, manure & fertilizer application, irrigation, land preparation and plant protection application were found to be highest energy utilized operations. Further, it was also observed that in case of the fertilizer application both direct (men 0.77%) and indirect energy (fertilizer 46.80%) sources contributed as highest energy sources individually as well and led to fertilizer application as the highest energy utilized component. In case of irrigation also, both direct (electricity 31.09%) and indirect energy (men 0.55%) sources contributed as highest energy sources individually as well and led to irrigation as the highest energy utilized component. In case of land preparation, direct (diesel 8.33%) energy sources contributed for the highest energy sources individually. The other energy sources for land preparation namely men, tractor and machinery were negligible (< 0.3%). In case of pesticide application, indirect (pesticide 4.53%) energy source contributed for the highest energy source component. The other energy sources for pesticide application namely men, women, electricity and machinery were negligible (< 0.4%).

Out of five direct energy sources, two sources namely electricity (31.18%) and diesel (9.55%), contributed for highest input energy sources. Out of four indirect energy sources, fertilizer (46.80%), pesticide (4.53%) contributed for highest energy utilization. Out of eight farm operations, fertilizer application (47.57%), irrigation (31.64%), land preparation (8.89%), plant

Table 2 : Energy sources (%) utilised for different package of practices of rose onion cultivation

Unit operation	Direct energy					Indirect energy				Total Energy (%)
	Men (%)	Women (%)	Tractor (%)	Diesel (%)	Electricity (%)	Seed (%)	Fertilizer (%)	Pesticide (%)	Machinery (%)	
Land preparation	0.08	0.00	0.48	8.33	0.00	0.00	0.00	0.00	0.01	8.89
Sowing	0.05	0.00	0.09	1.22	0.00	0.05	0.00	0.00	0.00	1.40
Thinning	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Manure & fertilizer	0.77	0.00	0.00	0.00	0.00	0.00	46.80	0.00	0.00	47.57
Plant protection	0.05	0.67	0.00	0.00	0.09	0.00	0.00	4.53	0.00	5.35
Irrigation	0.55	0.00	0.00	0.00	31.09	0.00	0.00	0.00	0.00	31.64
Harvesting	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71
Detopping	0.51	2.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.32
Total energy	2.01	5.30	0.57	9.55	31.18	0.05	46.80	4.53	0.01	100

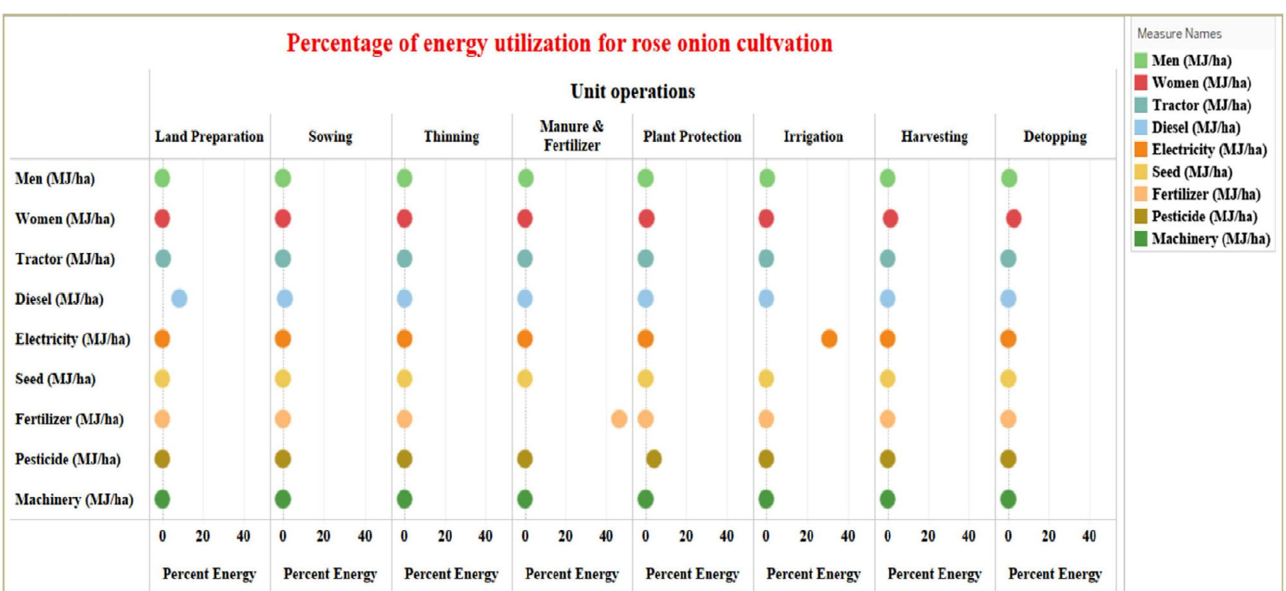

Fig. 2 : Percentage of energy utilised for rose onion cultivation

protection (5.35%) contributed for highest energy utilization.

Energy parameters

The different energy parameters *viz*., direct, indirect, total input, output energy, energy ratio, energy productivity and net energy in rose onion cultivation were observed to be 23,013.06 ± 230.41, 24,330.17 ± 415.36, 47,343.23 ± 484.65, 38,131.12 ± 462.48 MJ ha^{-1}, 0.81 ± 0.01, 0.50 ± 0.01 kg MJ^{-1} and -9,212.11 ± 540.56 MJ ha^{-1}, respectively (Table 3). The utilization of indirect input energy was higher than direct input energy (Fig. 3). It was clear that the utilization of indirect energy sources was significant from direct energy sources (Table 3). Further, from Table 2, it was noticed among the four indirect energy sources *viz*., seed, fertilizer, pesticide and machinery, fertilizer was the highest energy utilised source.

Table 3 : Energy parameters for rose onion cultivation

Onion type	Rose onion
Total direct energy (MJ ha^{-1})	23,013.06 ± 230.41
Total indirect energy (MJ ha^{-1})	24,330.17 ± 415.36
Total input energy (MJ ha^{-1})	47,343.23 ± 484.65
Yield (Kg ha^{-1})	23,831.95 ± 289.05
Total output energy (MJ ha^{-1})	38,131.12 ± 462.48
Output/input ratio	0.81 ± 0.01
Energy productivity (Kg MJ^{-1})	0.50 ± 0.01
Net energy (MJ ha^{-1})	-9,212.11 ± 540.56

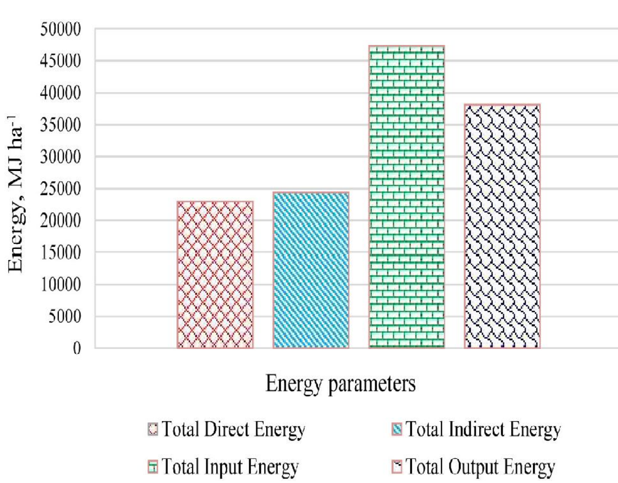

Fig. 3 : Total input and output energy utilised for rose onion cultivation

CONCLUSION

An energy audit study was conducted at Sadali village, Sidlaghatta, Chikkaballapur of Karnataka state to understand the energy use pattern of rose onion cultivation. The study concluded that the total input energy utilised for cultivation of rose onion was found to be 47,343.23±484.65 MJ ha^{-1} and output energy was 38,131.12±462.48 with the energy ratio of 0.81±0.01. Energy utilized for manure & fertilizer application operation was observed to be the highest as 47.57% followed by irrigation (31.64%) and land preparation (8.89%). The energy sources utilized for fertilizer application was observed to be the highest as 46.80% followed by electricity (31.18%) and diesel (9.55%). From the above study it was concluded that consumption of fertilizer, electricity and diesel should be optimized. In case of fertilizer, use of liquid fertilizes, and adoption of natural farming may be validated through research and then many be recommended to the rose onion growing farmers. By adopting using alternate fuels in tractor will lead to reduction in use of diesel consumption. Farmers should be encouraged to use solar powered irrigation pumps in place of electrical pumps to reduce the electrical energy. It was also clear that energy from farm women contributing significantly as input energy source. Farm women are engaged in weeding, harvesting and detopping operations in rose onion cultivation. Machineries are available for onion seeding, harvesting and detopping. These machineries need to be widely demonstrated to the onion growing farmers for adoption thus leading to reduction in input energy in onion cultivation.

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