The Bioscan 11(2): 857-861, 2016
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

ENERGY MANAGEMENT STUDIES OF TURMERIC CROP CULTIVATION

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KEYWORDS
Energy assessment
crop production
energy cost

Received on :
18.10.2015

Accepted on :
26.04.2016

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ABSTRACT
The present research work was carried out at three different villages viz,Sonkhas, Gorwha and Tamashi. This work was done to determine the total energy required in turmeric cultivation. On the basis of result obtained, it has observed that average cost of operation is more in intercultural operation. The total energy required to the turmeric cultivation at three different villages Sonkhas, Gorwha and Tamashi were comes to be 4042.72, 4562.55, 4310.05 MJ/ha respectively. This energy includes human labour as well as animal power. Average energy required for different operations like sowing, intercultural, irrigation, harvesting were observed to be 453.84, 1695.78, 285.09, 1870.4 MJ/ha respectively. It has showed that the average energy required is more in harvesting operation. The cost required to turmeric crop cultivation at Sonkhas, Gorwha and Tamshi was observed to be 53361.12, 39000, 39219.69 Rs/ha respectively. From the result we concluded that harvesting require large amount of energy.

INTRODUCTION

Energy forms one of the most crucial inputs in agriculture. The patterns of energy use in agriculture are crucially linked with the level of a technology adopted. It also depends upon the cropping pattern which differs from region to cropping pattern which differs from region to region. Study on the use of energy in agriculture has received a great deal of emphasis in a recent years with the increasing modernization of a traditional agriculture, energy in agriculture vales according to the type of farming area, the size of farm and level of technology(Conijn *et al.*, 2014). The use of energy in crop production depends on availability of energy sources in particular region and also on the capacity of the farmers. There is a need to carry out energy analysis of crop production system (practices) and to establish optimum energy input at different levels of productivity. The appropriate use of energy input to crop production food originates from several types of conservation practices. The reduction elimination or combination at machinery operation will reduce energy (fuel) input and also may reduce the uses of labour and time (Karale *et al*., 2008).

Human and animal energy is predominantly used in most of the farming operation in Vidarbha region, starting from land preparation to harvesting of the crop. Due to much involvement of labour in different operations, the cost of production of most of crops in our country is quite high as compared to developed countries. Also, the unavailability of human power due to migration towards town in peak period accounts more expenditure with less productivity (Namdari, 2011).

Therefore it needs to quantify the appropriate methods of farm operation, which reduces the energy cost with an increasing in output for sustainable development of agricultural sector. Verma *et al*., 2015 emphasized the method of mechanization for weed control of crop production. The present investigation deals with assessment of the energy consumption in the field operation and evaluation of cost of energy during the operation for turmeric crop.

MATERIALS AND METHODS

The present study was undertaken at Akola and Washim district of Maharashtra State. As the university is situated in Akola district considerable efforts has been made for transfer of technology related to the use of farm machineries and implements.

Description of the area

The present study was undertaken at Akola and Washim district of Maharashtra State. The farmers of cultivating turmeric were directly interviewed and the relevant data has been collected as per study requirement. Akola district is situated at central East side of Maharashtra state. The district lies between at 20º42″ North latitude and 70º 21″ East longitude. The district is surrounded by Amravati and Yavatmal district in East, Washim and part of Yavatmal in South and Buldhana in West.

Geographical, demographic and climatic situation of area

The total geographic area of Akola district is 5417 sq.km out of which Akola taluka constitute 1014 sq. km. Average annual precipitation 760 mm out of which approximately 85 % is received during June to September. The climate of the area is semiarid characterized by three distinct season namely

summer, becoming hot and dry from March to May, rainy season from June to October and winter with mild cold from November to February since tropic of cancer passes over it. Akola is immense more hot in May and June, mean annual maximum and minimum temperature are 32ºC and 26ºC respectively. Soil type of study area was medium black soil.

Crops

The majority crops grown in Akola district are dependent on rainfall. Cotton, sorghum, green gram, turmeric are the major crops. During rabbi season, the crops like safflower, wheat, and gram are grown. In addition of cotton, sorghum, soybean various fruits like citrus, banana, & oranges, orchards are grown.

Research design

The present study was based on exploratory design of social research and engineering aspect regarding the energy audit. An analytical research design was used for the present investigation. The study was mainly designed to collect pertinent facts about energy requirement in turmeric crop production. The emphasis is given on the studies of energy requirement in turmeric crop production and the cost of energy. Hence, the use of exploratory design of social research in present investigation was made.

Sampling plan and sampling technique

The present study is an attempt to find out level and use of energy pattern and economic. For that purpose a proper sampling plan and technique was followed.

Selection of respondents

Three farmers were selected for data collection from selected villages of small, medium, and large land holding sizes.

Development of data collection instrument

Data are vital component of any research study and therefore a prime requisite. There are number of methods and techniques used for data collection in energy requirement of turmeric crop studies, including interview schedule, questionnaire is the most commonly used method for data collection from the respondents. It is time saving, economical, more adequate and practical to measure respondent's attitude and opinions. Hence, it was used for the present study on the basis of objectives of study; an exhaustive structured questionnaire was designed and developed (Veiga, 2015).

Collection of data

Considering the nature of study at hand, the data were collected with the help of structure and pretested questionnaire developed for this purpose. The data collected through individual contact method (face to face) by contacting the selected farmers. The farmers were contacted at their home or in their farm as per their convenience for easy and quick approach with farmer. Before actual seeking information, farmers were explained the purpose of conducting research study and objective of present study.

Energy estimation

Central focus of an inquiry in the present study is centered on the computation of energy requirement for performing different agricultural operations. It therefore becomes an inevitable to discuss and describe the procedure followed for computation of energy required for performing different agricultural operations. For quantification of requirement of energy for performing various agricultural operations in turmeric, three types of energy were considered. The first one being mechanical energy, which included energy from diesel, which was worked out with quantity of diesel, multiplied by equivalent energy (MJ/ha) for important operations like land preparation, crop growing, intercultural, irrigation and harvesting *etc* (Hussian and Azlina, 2010, Fuska, *et al.,* 2013).

Based on the formula stated below the total mechanical energy was worked out as;

Mechanical energy (ME) = Q_D x h x N x EE

Where,

Q_D = Diesel required, litter per hectare,

h = Time required for operation, hour,

N = Number of operations performed,

EE = Energy equivalent.

For the purpose of estimating human energy is calculated by using following formula

Human energy (HE) = HLx h x N x EE

Where,

HL = Number of human labour,

h = hours of operation,

N = Number of operations followed,

EE = Energy equivalent.

The land preparation, crop growing, intercultural, irrigation and harvesting, *etc,*. were taken into account. Thus, with this formula and operations in consideration total human energy was worked out. Besides mechanical and human energy third type of energy which was considered in the present study was bullock energy. This energy however needed for performing operations such as land preparation, crop growing, intercultural, irrigation and harvesting, *etc*. Estimation of this kind of energy was done with the help of following equation for these two operations (Karale *et al.,* 2008).

Bullock energy (BE) = B_N x 0.5 x h x N x EE

Where,

B_N = Number of bullocks,

H = Hours of operation,

N = Number of operations followed,

EE = Energy equivalent.

The basic input required for the turmeric production of seed, fertilizer, organic manure, irrigation was considered to show the outlet of stated parameter in terms of energy for the input energy required for turmeric production.

Finally, in order to workout total requirement of energy summation of mechanical energy, human energy and bullock energy was considered together and thus total energy for crops under study was estimated. This can be shown through equation as below (Fadavi *et al*., 2011 & Foster *et al*., 1980).

Total energy = Mechanical energy + Human energy + Bullock energy

Energy analysis

The ratio of output energy to input is called as energy ratio. In general, the value of energy ratio should be greater than one. Computation of input output ratio of energy was calculated with the help of formula give below (Zaidi *et al.,* 1998, Neira *et al.*, 2013).

$$\text{Energy use efficiency} \quad \frac{\text{Output energy}}{\text{Input energy}} \quad 100$$

Specific energy or energy intensity has been widely used in energy analysis to express quantity of energy invested to produce unit quantity of product. The unit of specific energy is MJ/kg.

$$\text{Specific energy} \quad \frac{\text{Energy input (MJ/ha)}}{\text{Crop output (kg/ha)}}$$

Energy productivity which measures the quantity of production produce per unit of input energy (kg/MJ) i.e. inverse of specific energy was a third term used in energy analysis. This serve as an evaluator of how efficiently energy was utilized in production system yielding a particular product.

$$\text{Energy Productivity} \quad \frac{\text{Crop output (kg/ha)}}{\text{Energy input (MJ/ha)}}$$

The net energy of the turmeric crop production was determined using following formula.

Net energy = Energy output (MJ/ha) -Energy input (MJ/ha)

The input energy for various operations and the input deployed to the growing of turmeric was determined (Karale *et al.,* 2008, Shahin *et al*., 2008). The energy equivalent was taken and same are given in Table 1.

Cost of energy

In consonance with one of objectives, it was essential to work out energy consumed and cost incurred for performing various agricultural operations carried out in the cultivation of turmeric crops under study (Karale et al 2008, Karimi et al 2008, Dagistan et al, 2009).

Cost of production

Total input cost for farming including total cost determined for all operations and actual cost for different input products.

Cost of production (Rs/ha) = Total cost in all operation + cost of inputs.

Benefit cost ratio (considering cost of yield)

By adopting relationship between gross income and production cost, output input ratio for farm considering yield as output as under,

$$\text{Benefit cost ratio} \quad \frac{\text{Gross income (Rs)}}{\text{Pr oduction cost (Rs)}}$$

Cost of energy

By adopting relationship between cost of production and gross input energy cost of energy calculated as

$$\text{Cost of energy (Rs/MJ)} \quad \frac{\text{Gross cost of production (Rs/ha)}}{\text{Total input energy (MJ/ha)}}$$

RESULTS AND DISCUSSION

Operational energy assessment at Sonkhas

The total operational energy input for turmeric crop in 1.8 ha area was 4042.72 MJ/ha. Which is calculated from energy input in various operation of turmeric crop like sowing, intercultural, irrigation, harvesting as shown in table 2.

At the time of sowing total energy requirement was 125.50 MJ/ha. This work was done within 8 hrs by 65 female and 8 male. That is total energy input by female was 55.82 MJ/ha while by male it was 69.68 MJ/ha. Total energy requirement at the time of intercultural operation was 1475.45 MJ/ha. This operation required total 8 hrs for 150 female, 8 male and 8 pair of bullock. In which total energy input contributed by female is 1046.66 MJ/ha, by male 69.68 MJ/ha and by bullock pair is 359.11 MJ/ha. Shahin *et al.*, 2008, reported by similar energy assessment of wheat crop and found to be 38.36 GJ/ ha. Total energy requirement for irrigation operation was 87.11 MJ/ha. This was done by 10 male in 8 hrs. and harvesting operation had total energy requirement 2354.66 MJ/ha. In which total female required were 300 and 30 male for 8 hrs. The energy contribution by female is 2093.33 MJ/ha. , and by male it is 261.33 MJ/ha. Conijn *et al.,* 2014, has evaluated net energy yield ranged from 45 to 140 GJ/ha.

Operational energy assessment at Gorwha

The total operational energy input for turmeric crop in 1.8 ha area was 4562.55 MJ/ha. Which is calculated from energy input in various operation of turmeric crop like sowing, intercultural, irrigation, harvesting. Veigo et al 2015, worked out every balance for by whole Sugarcane. At the time of sowing total energy requirement was 558.22MJ/ha. This work was done within 8 hrs by 80 female. Total energy requirement at the time of intercultural operation was 1911.45 MJ/ha. This operation includes weeding, spraying and fertilizer operation. Weeding operation was done in 8 hrs, which required 180 females, 8 male and 8 bullock pair. In which total energy

Table 1: Energy equivalent of farm power sources

Sources of farm power		Equivalent(MJ)
a)	Human:	
1.	Male	1.96
2.	Female	1.57
b)	Draught animal	10.1

Table 2: Assessment of operational energy input in various operation of Turmeric crop

Particular	Sowing		Intercultural			Irrigation	Harvesting		Total operational energy, (MJ/ha)
	M	F	M	F	AP	M	M	F	4042.7
Number	8	65	8	150	8	10	30	300	
Hours	08								
Input energy, MJ/ha	69.8	55.8	69.6	1046	359.1	87.1	261.3	2093.0	

Where M = male; F = Female; AP = Animal power

Table 3: Energy involved in the field operation of turmeric cultivation

SN	Operation	Sonkhas(MJ)	Gorwha(MJ)	Tamshi(MJ)	Average energy use(MJ/ha)
1.	Sowing	125.50	558.22	677.8	453.84
2.	Interculture	1475.45	1911.45	1700.45	1695.78
3.	Irrigation	87.11	174.22	593.93	285.09

Table 4: Cost parameters of selected villages for various operations

SN	Operation	SonkhasCost(Rs/day)	GorwhaCost(Rs/day)	TamshiCost(Rs/day)	Average cost of operation, Rs
1	Sowing	11750	8000	18300	12683.33
2	Interculture				
3	Weeding	29300	25200	29280	27926.66
4	Spraying	0	2000	2640	2320
5	Fertilizer	0	2000	5760	7760
3	Irrigation	2500	4000	12000	6166.66
4	Harvesting	52500	29000	35500	39000
5	Total cost of operation	96050	70200	103540	89930
6	Cost per ha.	53361.12	39000	39219.69	43680.27

Table 5: Cost of energy in various operation of Turmeric

SN	Operation (MJ/ha)	Energy Use Rs/ha	Cost of operation, Rs/MJ	Cost of energy,			
				Sonkhas	Gorwha	Tamshi	Average
1.	Sowing	453.84	12683	93.62	14.33	26.99	44.98
2.	Inter culture	1695.78	38066	19.85	15.27	22.15	19.09
3.	Irrigation	285.09	6166.66	28.69	22.95	20.2	23.94
4.	Harvesting	1870.4	39000	22.29	15.11	26.53	21.31
5.	Average Energy use, MJ/ha	4305.11	89930	23.75	15.38	24.022	21.05

input contributed by female was 1256 MJ/ha, by male 69.68 MJ/ha and by bullock pair it was 359.11 MJ/ha. Spraying operation has total energy input 87.11 MJ/ha. This was done by using 10 males for 8 hrs. While fertigation operation has total energy input 139.55 MJ/ha for 20 females for 8 hrs. Total energy requirement for irrigation operation was 174.22 MJ/ha. This was done by 20 male in 8 hrs. While harvesting operation had total energy requirement 1918.66 MJ/ha. In which total female required were 250 and 20 male for 8 hrs. The energy contribution by female was 1744.44MJ/ha and by male was 174.22MJ/ha. Neira *et al.,* 2014, evaluated energy analysis of organic farm in Spain. Similar assessment of energy in crop production is reported by Namdari, 2011.

Average energy required for different operation of turmeric crop cultivation.

Average of total energy use for turmeric crop cultivation was calculated, by considering energy required for different operation in turmeric cultivation at three different villages. Average energy required for sowing, intercultural, irrigation and harvesting was 453.84 , 1695.78, 285.09, 1870.4 MJ/ha respectively. According to this total average energy required was 4305.11 MJ/ha as shown in table 3. Dagistan et al 2009, investigated the average energy consumption of the farm is about to be 19558 MJ/ha. Similar results have been reported by Klimekova & Lehockra, 2007 in conventional farming system. Faska et al 2013 reported the energy balance in catch crop production.

Cost parameters of selected villages for various operations

Average cost of operation for turmeric crop cultivation was calculated, by considering cost for different operations in turmeric cultivation at three different villages. Average cost required for sowing, intercultural, irrigation and harvesting was 12683.33, 38006.66, 6166.66, 39000 Rs / Day respectively (Table 4). According to this total average cost of operation were 89930 Rs/day. Total cost per ha was 43680.27 Rs. Total cost of turmeric cultivation was 53361.12, 39000, 39219.69 Rs/ ha at Sonkhas, Gorwha and Tamshi respectively. The cost is high in in Sonkhas village because of large number of labour required as well as wages are high as compared to other. Bielski 2015, reported the energy balance and evaluation in crop production. Similary Fedavi et al 2014 worked out the benefit-cost ratio of crop production for energy and found to be 1.77.

Cost of energy in various operation of turmeric cultivation

Average cost of energy required for different operation like sowing, intercultural, irrigation and harvesting was 44.98, 19.09, 23.94 and 21.31 Rs /MJ respectively. Total cost of energy for cultivation of turmeric crop was 21.05 Rs /MJ. Total cost of energy calculated at different villages like Sonkhas, Gorwha and Tamshi is 23.75, 15.38 and 24.022 Rs /MJ respectively (Table 5). Karimi, *et al.,* 2008, evaluated the total energy expenditure of about 148.02 GJ/ha. Karale *et al* .,2008, evaluated the cost of energy in traditional energy over mechanized practices.

It has been observed that the energy costs in the operations are the reflection of intensive labours used in the farming. The cost of traditional energy is more and which greatly influences on the production cost. Thakur *et al.,* 2015 reported the

economics of sweet corn production. This project suggests the use of appropriate machines in the various operations in turmeric crop production. Himanshu *et al.,* 2012, analyzed cost of energy for traditional farming compared the mechanized farming and at comes to be 1.2 time more in traditional farming. The traditional operational energy requirement for Sonkhas, Gorwha and Tamshi village 4042.72, 4562.55, 4310.05 MJ/ha respectively. Average energy required for different

operations like sowing, interculture, irrigation, harvesting was observed to be 453.84, 1695.78, 285.09, 1870.4 MJ/ha respectively. The cost required to turmeric crop cultivation at Sonkhas, Gorwha and Tamshi was observed to be 53361.12, 39000, 39219.69 Rs/ha respectively. Average cost of energy for different operations like sowing, interculture, irrigation, harvesting was observed to be 27.94, 22.44, 21.63, 20.85 Rs/MJ respectively.

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