Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6232

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (2):** 304-310 (2018)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Energy Requirement and Management in Castor Production

Kumar Naik, A. H.[1] and Sridhara, S.[2*]

[1]Assistant Professor of Agronomy, All India Coordinated Research Project on Castor, Zonal Agricultural, and Horticultural Research Station, Babbur Farm, Hiriyur, Karnataka.577 598

[2]Professor of Agronomy, University of Agricultural & Horticultural Sciences, Shimoga

*Corresponding Author E-mail: kumarahphd@gmail.com

Received: 7.02.2018 | Revised: 15.03.2018 | Accepted: 21.03.2018

ABSTRACT

Mechanization of agricultural field operations sooner than later is the need of the hour in the present Indian Agriculture. Mechanisation of critical operations for rainfed castor crop requires special attention for achieving higher productivity to meet the future demands and challenges of food security. This study was carried out to study the impact of mechanization of critical operations like sowing, inter-cultivation and shelling on productivity and economics of castor cultivation under medium black soil both conventional method and mechanized method. The study reflects the energy use patterns in mechanized and traditional farming system. Results showed that the performance of castor in selective mechanization imposed plot, the total input energy required in the cultivation of castor crop was 9518 MJ /ha which accounted higher by 352 MJ/ha as compared to the normal plot (9166 MJ/ha). Whereas, energy output (31561 MJ/ha), net energy returns (21683 MJ/ha), specific energy (4.4 MJ/ha) and energy productivity (0.23 kg/MJ) were higher with selective mechanization as compared to normal cultivation (27563 MJ/h; 18397; 4.89 MJ/ha; 0.20 kg/MJ). The flow of energy use efficiency in the mechanized plot (3.67kg/MJ/unit) was slightly higher than normal plot (3.3 kg/MJ/unit). Net energy returns (MJ/ha) also quite higher in the mechanized plot (20, 105 MJ/ha) than normal plot (16,135 MJ/ha) (Table 4). Overall it is seen that the application of modern implements and machinery for the crop production over the traditional practices reduces the cost of production which surely impact on the crop production and the net income of the farmers.

Key words: *Traditional, Mechanical, Energy, Castor*

INTRODUCTION

The relation between agriculture and energy is very close. The agricultural sector itself is an energy user and energy supplier in the form of bio-energy[3]. In the development process of humanity, energy is playing a key role. Energy is one of the most valuable inputs in production agriculture. It is used in various forms in large quantities of locally available non-commercial energies, such as seed, farmyard manure and animate energy, and commercial energies directly and indirectly in the form of electricity, diesel fuel, chemical fertilizers, plant protection, irrigation water and farm machinery[8].

Cite this article: Naik, K.A.H. and Sridhara, S., Energy Requirement and Management in Castor Production, *Int. J. Pure App. Biosci.* **6(2):** 304-310 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6232

Nowadays, energy usage in agricultural activities has been intensified in response to continued growth of human population, the tendency for an overall improved standard of living as well as to meet other social and economic goals[9]. Sufficient availability of the right energy and its effective and efficient use are prerequisites for improved agricultural production. The crop yields and food supplies are directly linked to energy[11]. In the developed countries, increase in the crop yields was mainly due to increase in the commercial energy inputs in addition to improved crop varieties[4]. Particularly in developing countries, the primary objectives of mechanizing crop production are to reduce human drudgery and to raise the output of farm by either increasing the crop yield or increasing the area under cultivation[6]. These can only be done by supplementing the traditional energy input, i.e. human labour with substantial investments in farm machinery, irrigation equipment, fertilizers, soil and water conservation practices, weed management practices, etc. These inputs and methods represent various energies that need to be evaluated to ascertain their effectiveness and to know how to conserve them. Energy analysis, therefore, is necessary for efficient management of scarce resources for improved agricultural production[12]. The other benefits of energy analysis are to determine the energy invested in every step of the production process (hence identifying the steps that require least energy inputs), to provide a basis for conservation and to aid in making sound management and policy decisions. In agriculture sector of India, the energy use pattern for unit production of crops has varied under different agro-climatic zones. The use of energy in crop production depends on the 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 [7].

Castor crop is grown in a large area under rainfed conditions of Karnataka, Andhra Pradesh, Maharashtra, Gujarat, and Tamilnadu. The productivity of castor in Karnataka during *kharif* season in the state is low and varies from 560 to 836 kg/ ha. It is far below than that of Gujarat (2061 kg/ ha), Haryana (1667 kg/ ha), Rajasthan (1465 kg/ ha) and national average (1653 kg/ ha) (AICRP-Castor 2014). This is due to adverse weather conditions in addition to limited resources with poor soils and predominant use of human and animal energy in most of the farming operations starting from land preparation to harvesting, threshing of the crops accounts more expenditure with less productivity. Hence, the resource management and timeliness of operations play a wider role to increase the productivity under dryland conditions. With advancement in land productivity in Indian agriculture, use of improved implements and machines operated by electro-mechanical power sources have increased to a great extent and reduced the cost and drudgery involved in castor cultivation and also increase the yields of the castor and to make the farmer self-supportive in agricultural operations. Keeping the given above facts AICRP on Castor, Hiriyur attempted for selective mechanization in the cultivation practices by availing a castor planter for sowing, weeder for intercultivation and sheller for shelling operations developed at ZAHRS, Hiriyur to study their impact on productivity and economics of castor crop production.

MATERIAL AND METHODS

The present research work was carried out for four consecutive years (2013-14, 2014-15, 2015-16 and 2016-17) during the *Kharif* seasons at Zonal Agricultural and Horticultural Research Station, Hiriyur. The objective is to study the impact of mechanization of critical operations like sowing, intercultivation and shelling on productivity, the economics of castor cultivation under the medium black soil, both traditional method and mechanized method was studied in a one-acre land with the non-replicated design. The kinds of farm implements used were shown in Table 1. Similarly, the energy consumption of the various operations of the castor crop production both conventional method and mechanized method has been recorded. The experimental site showed a pH of 7.7, low available nitrogen (162 kg ha^{-1}) and phosphorus (16.2 kg ha^{-1}), medium available potassium (270 kg ha^{-1}). Castor variety DCH 177 was sown at spacing of 90 cm (between rows) x 60 cm (plant to plant) and common fertilizer dose of 40 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha^{-1} was applied. The total rainfall received during 2013-14, 2014-15, 2015-16 and 2016-17 was 513, 852, 784 and 312 mm, respectively, and total rainfall received during crop growth period (June to December) was 311, 725, 624 and 230 mm with 15, 30, 37 and 23 rainy days, respectively. The crop was raised by following the recommended package of practices.

The data on time period for each operation, labour used (number) for each operation, energy used, were converted into suitable energy units and expressed in mega joules per hectare (MJ/ha.). Energy equivalents of inputs and outputs are given in Table-2. The inputs used in the calculation of agricultural energy use include human labor, machinery, electricity, fertilizers, pesticides, and seeds. For the estimation of energy input for agriculture, working days of agricultural workers were taken as an average of 8 h of work a day. In the calculation of chemical energy input information on individual fertilizer used was not available; therefore, amounts of three main kinds of fertilizers (nitrogen, phosphate and potash) were used in the estimation. Amount of pesticide was also converted to energy equivalent. The measurements of fuel and electricity consumption, operation time and crop yield were done in the field, where time at the beginning and end of the operation is recorded with a stopwatch. Time spent on major breakdowns, if any was excluded from the operation time. However, the time for minor field adjustments was included in the operation time. Measurement of the amount of fuel consumed for performing particular field operation with the tractor was done with the help of top filling method. A 12.5 hp electric motor was used for irrigation. The reading of energy meter at the beginning and the end of the irrigation was recorded. From this, the total amount of electricity consumption in kilowatt-hours (kWh) was calculated. The calculation of energy input and output equivalents, the indices of energy ratio (energy use efficiency), energy productivity, specific energy (energy intensity) and net energy were calculated as follow[9]

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

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

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

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

Table 1: Use of farm implements in castor

Operation	**Selective Mechanized Plot**	**Normal plot** (Location specific farm implements)
Land preparation	Mould board plough, rotovator	Bullock drawn implements
Sowing	Seed cum fertilizer drill	Hand dibbling/Manual
Inter culturing	Power weeder/power tiller	Normal intercultivation
Need-based plant protection	Motorized/power sprayers	Knapsack sprayer
Harvesting	Secateurs	Manual
Post-harvest	Using castor shellers/Threshers	Manual

Table 2: Energy unit conversion equivalents for direct and indirect sources of energy

	Particulars	Units	Equivalent energy (MJ)
I. Inputs			
Human labour	Man	Man hour	1.96
	Woman	Woman hour	1.47
	Child	Child hour	0.98
Animals	Bullocks	Pair hour	10.1
Petrol		Litre	48.23
Machinery	Farm machinery	Kg	16.416
Chemical fertilizers	Nitrogen	Kg	60.0
	Phosphorus	Kg	11.1
	Potassium	Kg	6.7
Organic manure	Farm yard manure	Kg (dry wt)	0.3
	Goat manure	Kg (dry wt)	0.3
	Rabbit manure	Kg (dry wt)	0.3
	Pig manure	Kg (dry wt)	0.6
Chemicals	Super chemicals	Kg	120
Seed	All crop seeds	Kg (dry wt)	14.7
II. Out puts			
Grain	All grains	Kg (dry wt)	14.7
Straw	Stover and grasses & haulms	Kg (dry wt)	12.5

(Gopalan *et al.*, [5])

RESULTS AND DISCUSSION

Operation wise energy consumption for traditional and mechanized operations

The energy consumed in mega joules per hectare (MJ/ha.) in respect of various field operations for both selective mechanized and normal method of cultivation of castor (Average of four years) were depicted in **Fig. 1**.

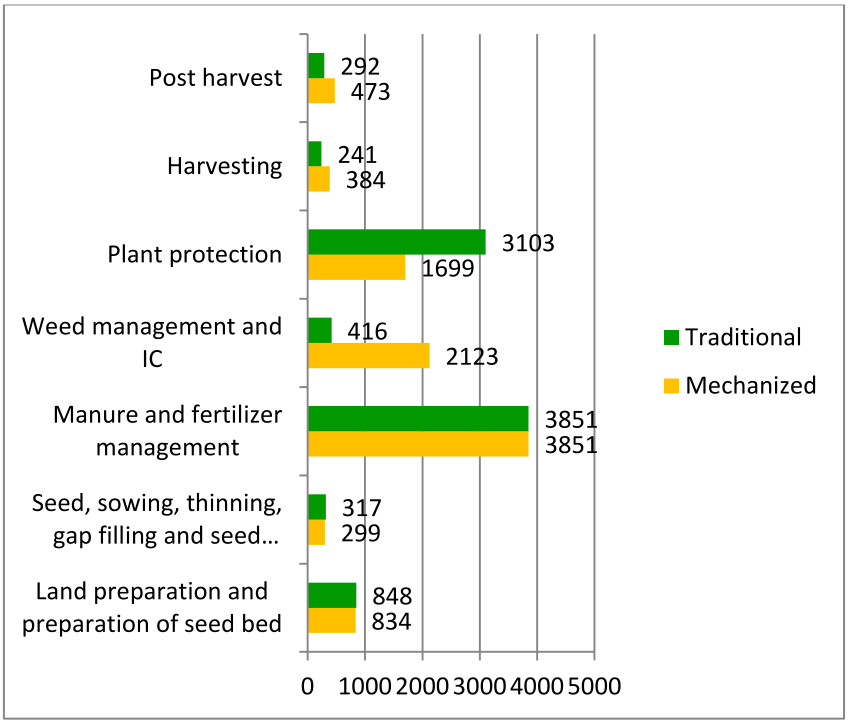

Fig. 1:

Fig.1. The energy consumed in mega joules per hectare (MJ/ha.) in respect of various field operations for castor cultivation (Average of four years)

In the operation wise the pooled data of four years energy use pattern, it was observed that the flow of energy in manure and fertilizer application required more energy in both the method *i.e.* 3851 MJ/ha. This is due to similar recommended dose of fertilizer in both the cultivation method, followed by weed management and intercultural operations where energy requirement was more in mechanized method 2123 MJ/ha over the normal method 416 MJ/ha. As observed in the present study, similar benefits of mechanization in castor were also obtained in Yethapur, Tamilanadu[2] and also these findings are in line with Seyed and Singh 2009 stating that the cost regarding weeding and hoeing was less for mechanized method than the traditional method. It might be due to the precision work was done by tractor operated cultivator. In case of plant protection, the consumption of energy was quite high to the tune of 3103 MJ/ha in the normal method as compared to the mechanized method (1699 MJ/ha). Similarly, the energy requirement pattern in sowing was more in nonmechanized method (317 MJ/ha) over mechanized method (299 MJ/ha) this also includes energy spent on seeds, thinning, gap filling and seed treatment. Such type of operations requires more manpower. (Table 3)

Substantial economics of tillage energy use in castor production can be achieved by the adoption of energy conserving tillage practices employing energy efficient implements that allow timely planting and the complimentary use of tractors. It is important to ensure that appropriate implements are specified so that tillage energy inputs are kept to a minimum. In both the method, tractor operated mould board plough was used for the opening of land and for smoothening of land bullock drawn harrow was used in the traditional method, whereas in mechanized method tiller was used. It was observed that the energy requirement was observed to be 834 MJ/ha and 848 MJ/ha in mechanized and nonmechanized method respectively. The energy requirement and cost of operation was observed more in traditional method than mechanized method; This was due to per unit cost of traditional operational energy was observed to be more due to the high amount of man and animal power requirement with costly wages. Further, in both the method, harvesting operation was carried out by labour by manually using sickle in normal method and secateurs in the mechanized method, It was noticed that energy requirement was observed to be 384 MJ/ha and 241 MJ/ha in mechanized and traditional method respectively. Similarly, post-harvesting (threshing) operation was done in the rain fed castor crop by power operated threshers in mechanized methods and stick beating or stone rolling carried out by manual labour in the normal method, the expenditure of energy for threshing is maximum 473 MJ/ha in mechanized method over 292 MJ/ha in the normal method. This was due to energy developed by man power costly than the mechanical power (Table 3).

Indices wise energy consumption for traditional and mechanized operations

The inputs used in the calculation of energy use included- land preparation, human labor (working days of agricultural workers were taken eight hr of work a day), machinery, electricity, fertilizers, pesticides and seeds, harvest, processing and post-harvest.

In mechanization imposed plot, the total input energy required in the cultivation of castor crop was 9518 MJ /ha which accounted higher by 352 MJ/ha as compared to the normal plot (9166 MJ/ha). Higher energy output (31561 MJ/ha), net energy returns (21683 MJ/ha), specific energy (4.4 MJ/ha) and energy productivity (0.23 kg/MJ) were noticed with selective mechanization as compared to normal cultivation (27563 MJ/h; 18397; 4.89 MJ/ha; 0.20 kg/MJ). It might be due to more man and animal hours were engaged in the traditional farming operation, which required more wages with less energy production capacity. Karale *et al.*[7] determined cost of energy of the soybean crop with the mechanized farming is the best option for maximized the net profit of the small farmers in the region.

The flow of energy use efficiency in the mechanized plot (3.67 kg/MJ/unit) was slightly higher than normal plot (3.3 kg/MJ/unit). Net energy returns (MJ/ha) also quite higher in the mechanized plot (20, 105 MJ/ha) than normal plot (16,135 MJ/ha) (Table 3).

Comparative time and labour requirements due to selective mechanization and non-mechanization in castor cultivation (Period (hrs)/ha)

The pooled analysis of the yield data indicated that performance of castor in selective mechanization plot recorded significantly increased the seed yield (2362 kg/ha). It recorded 17.6% higher seed yield than that of the normal plot (2007 kg/ha). The higher yield may be due to the usage of tractors and power weeder for interculivation practices and secateurs and thresher in the mechanized plot, lead to saving of 58 labour/ha and saved 491hrs / ha (Table 4) through selective mechanization of important operations. The results were in agreement with the findings of Saeed Firouzi and Hashem Aminpanah[10] who reported that Energy output-input ratio, specific energy, energy productivity, and net energy gain computed were 3.93, 4.74 MJ/kg, in semi-mechanized groundnut production. Yadav *et al.*[13] also documented similar results in the cultivation of rice and maize crops in Sikkim.

Table 3: Energy requirements due to selective mechanization in castor cultivation (Energy MJ/ha)

Particulars	Mechanized plot					Normal plot				
	2013	2014	2015	2016	Mean	2013	2014	2015	2016	Mean
Land preparation and preparation of seed bed	376	391	1285	1285	834	579	482	1166	1166	848
Seed, sowing, thinning, gap filling and seed treatment	268	389	286	255	300	160	339	416	355	318
Manure and fertilizer management	3847	3853	3853	3853	3852	3847	3853	3853	3853	3852
Weed management and IC	1814	2369	2745	1567	2124	414	470	548	235	417
Plant protection	1336	1890	1906	1667	1700	2364	3442	3474	3135	3104
Harvesting	125	156	157	1097	384	213	251	282	219	241
Post harvest (threshing & marketing)	483	470	470	470	473	260	329	329	251	292
Total energy input (MJ/ha)	8250	9518	10702	9207	9419	7839	9166	10070	9213	9072
Energy output (MJ/ha)	34016	31561	38558	13965	29525	29576	27563	31385	12304	25207
Net energy returns (MJ/ha) (EO - EI))	25766	22043	27855	4758	20106	21738	18397	21315	3090	16135
Energy use efficiency (EO/EI)	4.1	3.3	3.6	1.5	3.1	3.8	3.0	3.1	1.3	2.8
Specific energy (E.I. MJ/ha /Castor yield Kg/ha)	3.6	4.4	4.1	9.7	5.4	3.9	4.9	4.7	11.0	6.1
Energy productivity (kg/MJ)	0.3	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.1	0.2
Seed yield (kg/ha)	2314	2147	2623	950	2009	2012	1875	2135	837	1715

Table 4: Comparative labour and time requirements due to selective mechanization and non-mechanization in castor cultivation (Average of four years)

Particulars	**Time period (hrs)/ha**		**Manday/Labour used (Nos.)/ha**	
	Mechanized	**Non-Mechanized**	**Mechanized**	**Non-Mechanized**
Land preparation and preparation of seed bed	23.0	122.0	1.5	7.8
Seed sowing, thinning, gap filling and seed treatment	84.0	124.5	10.0	16.0
Manure and fertilizer management	40.0	40.0	5.0	5.0
Weed management and IC	65.5	226.0	6.3	28.3
Plant protection	76.0	120.0	7.3	10.5
Harvesting	74.0	130.0	9.3	16.3
Post harvest (threshing & marketing)	79.8	156.0	9.5	19.5
Total	442	919	48.75	103.25
savings	476		54.5	

CONCLUSION

The mechanized cultivation would enhance the productivity of the crops in all rain fed areas with profound effects on the socio-economic conditions in the rural areas. Mechanization could be a powerful tool to check migration of rural labour and to realize higher yield. Mechanisation of critical operation equipment in the dry farming and would go a long way not only in enhancing the productivity but also in improving the quality of work of the rural labour force, apart from this, labour problem can be solved by selecting location specific farm implements on a regional scale. Overall, considerable savings to the farmers' that enable him to get more income from the farm lands could be expected to lead to more contribution to the national income.

REFERENCES

1. Anonymous, All India Coordinated Research Project on Castor. *Annual Report* (2013–14), ICAR-Indian Institute of Oilseeds Research. *Hyderabad*, 500 030 (2014).
2. Anonymous, All India Coordinated Research Project on Castor. *Annual Report* (2014–15). ICAR-Indian Institute of Oilseeds Research, *Hyderabad*-500 030 (2015).
3. Alam, M.S., Alam, M.R. and Islam, K.K., Energy Flow in Agriculture: Bangladesh. *American Journal of Environmental Sciences* **1:** 213-220 (Bebendra & Bora, 2008) (2005).
4. Faidley, L. W., Energy and agriculture. In: R.C. Fluck (Ed), *Energy in Farm Production*, Elsevier, *Amsterdam*: 1-12 (1992).
5. Gopalan, C. B., Ramasastri, V. and Balasubramanian, S. C., *Nutritive value of Indian foods* (Hyderabad: National Institute of Nutrition) (1978).
6. Jekayinfa, S.O., Energy consumption pattern of selected mechanized farms in Southwestern Nigeria. *Agricultural Engineering International. The CIGR Ejournal*, Manuscript EE 06 001, VIII (2006).
7. Karale, D. S., V. P. Khambalkar, S. M. Bhende, Shraddha B. Amle and Pranali S. Wankhede., Energy economic of small farming crop production operations. *World Journal of Agricultural Sciences*, 4 (4), 476-482 (2008).
8. Kizilaslan, H., Input-output energy analysis of cherries production in Tokat Province of Turkey. *Applied Energy* **86:** 1354-1358 (Ozkan *et al*., 2004) (2009).
9. Rafiee, S., Mousavi Avval, S.H. and Mohammadi, A., Modeling and sensitivity analysis of energy inputs for apple production in Iran. *Energy* **35:** 3301-3306 (2010).
10. Saeed Firouzi and Hashem Aminpanah., Energy Use Efficiency for Groundnut (*Arachis hypogaea* L.) Production in a Semi-mechanized Cultivation System. *Annals of Biological Research,* **3(8):** 3994-3997 (2012).
11. Stout, B. A., Handbook of energy for world agriculture. *Elsevier Applied Science*, London (1990).
12. Vivek Khambalkar, Jyoti Pohare, Sachin Katkhede, Dipak Bunde and Shilpa Dahatonde, Energy and Economic Evaluation of Farm Operations in Crop Production, *Journal of Agricultural Science,* **2(4): 191-200 (**2010).
13. Yadav, S. N., Chandra, R., Khura, T. K. and Chauhan. N. S., Energy input–output analysis and mechanization status for cultivation of rice and maize crops in Sikkim. *Agric Eng Int: CIGR Journal* **15(3):** 108 (2013).