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A Study on Energy Use Pattern for Banana Production in Erode District of Tamil Nadu

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The energy consumption of banana production has been in Erode district of Tamil Nadu, India. Results showed that highest share of energy was recorded in nitrogen fertilizer (33.38 %) and planting material sucker (21.21%). The overall value of energy input use was 52955.4 MJ.ac^{-1} and output as produced 136172 MJ.ac^{-1}. The impacts of indirect and non-renewable energy on banana production were higher than direct and renewable energy. Energy input-output ratio, specific energy, energy productivity, energy intensiveness and net energy were 2.56 MJ.ac^{-1}, 4.59 MJ.kg^{-1}, 0.21 Kg.MJ^{-1}, 0.68 MJ.Rs^{-1} and 83216.60 MJ.ac^{-1}, respectively. Total cost of cultivation of banana was Rs.77, 800/ac. The results suggested that farmers should use only recommended fertilizers at recommended dose. As energy conservation measure, the farmers are advised to increase their economic productivity of banana farms by efficient use of energy.

Key words: Banana, Energy use pattern, Net energy.

Banana *(Musa* spp*)* is the most important horticultural crop. The largest banana grower in the world is India, which produced 29 million tonnes per year on an average between 2010 and 2015. China has produced 11 million tonnes during 2015-16 (FAO report, 2016). Production in both countries mostly serves domestic market.Production of banana in India has been increased from 12.11 MT in 2005-06 has increased up to 29.14 MT in 2015-16, which shows 17 per cent increase in production. Similarly, productivity also increased from 28.6 Mt.ha^{-1} in 2005-06 to 34.6 Mt.ha^{-1} in 2015-16 which shows increase in productivity of by6%. Tamil Nadustands first in India in terms of area (94610 ha) and production (4331650 MT) followed by Gujarat and Andhra Pradesh (NHB report, 2017). Modern agriculture is highly dependent on its inputs, except for land and solar energy. It also competes with other sectors of the economy for labour, capital, water, chemicals and energy (Dvoskin, 1981). Efficient use of energy resources is imperative in terms of increasing production, productivity and competitiveness of agriculture. Energy input-output analysis is usually used to assess the efficiency and environmental impactof the production systems (Ozkan *et al.,* 2004).

An energy analysis can designate ways to decrease energy inputs and increase energy efficiency (Kaltsas *et al.,* 2007) without impairing the economics of production. Minimizing energy inputs is necessary, but not sufficient to obtain an economic benefit. Low energy inputs production systems are not well acknowledged by farmer, who are interested in economic benefits rather than in energy productivity. A combination of economic, environmental and energy analysis of a production system may be more useful for the application of best farm management strategies (Reganold *et al.,* 2001; Pimentel *et al.,* 2005).In this regard, efficient use of energy by the agriculture sector seems to be one of the conditions for sustainable agriculture, because it allows financial savings, fossil resources preservation and air pollution decrease (Pervanchon *et al.,* 2002).

The aim of this study was to quantify energy flow in banana production with a specific objective of calculating energy input-output ratio, energy productivity and specific energy used in banana production.

Material and Methods

Sampling and data collection

The area chosen for study was Erode district which is one of the major banana growing districts in Tamil Nadu accounted for 9920 ha. Three blocks in Erode district and from each block, three villages were selected at random with the sample size of 100 farmers who were cultivating kathali, red banana and robusta varieties. Primary data were collected using pre-tested interview schedule through personal interview method. The conversion factorwas used to calculate the input and output energies of various operations like tillage, hoeing, transportation, irrigation, fertilizer application, spraying, harvesting, etc., and it is presented in the Table 1.

The different energy efficiency parameters such as energy ratio, specific energy, energy productivity, energy intensiveness and net energy yield were determined to evaluate relationship between energy consumption, total production and productivity was

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suggested by (Singh *et al.,*1997), (Mani *et al.,*2007). They are:

I. Energy ratio = $\frac{\text{Output energy (MJ.ac}^{-1})}{\text{Input energy (MJ.ac}^{-1})}$

II. Specific energy = $\frac{\text{Energy input (MJ.ac}^{-1})}{\text{Output (Kg.ac}^{-1})}$

III. Energy productivity = $\frac{\text{Output (Kg.ac}^{-1})}{\text{Energy input (MJ.ac}^{-1})}$

IV. Energy intensity= $\frac{\text{Energy input (MJ.ac}^{-1})}{\text{Cost of production (Rs.ac}^{-1})}$

V. Net energy yield= Energy output (MJ.ac^{-1}) - Energy input (MJ.ac^{-1})

The input energy was examined as direct and indirect, renewable and non-renewable forms. The mode wise energy sources used in agricultural production were calculated.*i.e.*Direct energy indicates human labour, petrol, diesel, electricity and water; Indirect energy shows seeds, fertilizers, farmyard manure, chemicals and machinery; Renewable energy signifies human, seeds, farmyard manure and water and Non-renewable energy implies petrol, diesel, electricity, chemicals, fertilizers and machinery.

Based on the availability of energy equivalent coefficient values both total input and output energies for banana cultivation were estimated.

Results and Discussion

Input-output energy of banana

Banana is an annual crop and consumed the large amount of energies and it is presented in Table 2.

Table 1. Energy content of inputs and outputs

Item	Unit	Energy equivalent (MJ.unit^{-1})	Reference
Human Labour	Hour (h)	1.96	Mani et al., 2007
Machinery			
Tractor	h	64.80	Devasenapathy et al., 2009
Sprayer	h	23.80	Fluck, 1985
Irrigation	h	2.40	Fluck, 1985
Transport	h	71.30	Fluck, 1985
Fertilizers			
N	kg	60.60	Devasenapathy et al., 2009
P	kg	11.10	Devasenapathy et al., 2009
K	kg	6.70	Devasenapathy et al., 2009
FYM	kg	0.30	Mani et al., 2007
Chemicals			
Insecticides	kg	278	Meul et al., 2007
Fungicides	kg	276	Meul et al., 2007
Herbicides	kg	255	Meul et al., 2007
Suckers	kg	7.10	Singh et al., 1992
Diesel-oil	L	56.31	Mani et al., 2007
Electricity	KWH	11.93	Mani et al., 2007
Irrigation	Metric cube	0.63	Mani et al., 2007
Output			
Banana	Kg	11.80	Handan, 2011

For banana cultivation various forms of energies were utilized viz., human energy, machine energy, fertilizer energy, chemical energy, seed (sucker) energy, diesel energy, electrical energy and irrigation water energy. The input wise use and energy equivalent values are presented in Table 2. The results revealed that accounted for the major share in terms of energy equivalent with 27621.6 MJ.ac^{-1}*i.e.* 48.40%.

Table 2.Input-output energy use in banana production (n= 100)

Inputs	Quantity. unit^{-1} area (ac)	Total energy equivalent (MJ.ac^{-1})	Percentage to total energy input
Human labour (h)	342.32	670.94	1.26
Machinery (h)	173.24	1921.76	3.62
Nitrogen (kg)	292.00	17695.20	33.38
Phosphorus (kg)	408.00	4528.80	8.54
Potassium (kg)	513.00	3437.10	6.48
FYM (kg)	6535.00	1960.50	3.69
Chemicals (kg)	7.90	2137.08	4.03
Diesel (L)	8.10	456.11	0.860
Electricity (KWH)	522.20	6229.84	11.75
Irrigation water (m3)	4242.00	2672.46	5.04
Sucker (kg)	1583.90	11245.69	21.21
Total energy input (MJ)		52955.40	100
Output			
Yield (kg)	11540	136172	
Total energy output (MJ)		136172	
Total cost of cultivation (Rs.ac^{-1})	77800		

Nearly half of the energy consumption was contributed by fertilizers for banana production but recommended fertilizer dose of banana was 626 kg.ac^{-1}having energy equivalent of 14516.5 MJ.ac^{-1}. Here almost 13105.05 MJ.ac^{-1} of fertilizer energy was excessive.Recommended dose of fertilizer is more than sufficient for improving resource use efficiency and to achieve higher yield (Spiertz *et al.,* 2009). Next to fertilizer, planting material (sucker) occupied the second major energy contribution with 11245.69 MJ.ac^{-1} i.e. 21.2 %. Since, planting material is one of the most important inputs for determining the yield in any crop production.

Diesel is one of the least consuming energy in banana production having 456.11 MJ.ac^{-1} with 0.86% because many of farmers used electricity for lifting the water from pump and mainly due to supply of free electricity. Use of diesel engine was not a better option for irrigation because of hike in price of diesel continuously. It is also suggested to save diesel fuel through using electricity for water extraction and improving machinery operating performance (Mohammadi, 2010). As well as when compared to machine with human energy, machine energy was more (2.35%) and shows that improvement in machineries usage over the human labour. Overall, banana production involves total energy input of 52955.4 MJ.ac^{-1} and total output energy of 136172 MJ.ac^{-1} having the total yield of 11540 kg.ac^{-1} which coincides with the result of (Handan, 2011).

Energy input-output and efficiency

The energy input-output and efficiency calculations for banana production are presented in Table 3.

Table 3. Energy input-output and efficiency calculations in banana production

Items	Unit	Values
Energy input-output ratio	MJ.ac^{-1}	2.56
Specific energy	MJ.kg^{-1}	4.59
Energy productivity	Kg.MJ^{-1}	0.21
Energy intensiveness	MJ.Rs^{-1}	0.68
Net energy	MJ.ac^{-1}	83160.60

It was observed that specific energy was highest with value of 4.593 MJ.kg^{-1} followed by energy input-output ratio (2.568 MJ.ac^{-1}), energy intensiveness (0.681 MJ.Rs^{-1}) and energy productivity of (0.217 kg.MJ^{-1}). Energy input-output ratio of2.5 MJ.ac^{-1} indicated that flow of input and high output energy wise 52955.4 MJ.ac^{-1} and 136172 MJ.ac^{-1}, respectively and showed that energy use was efficient in banana production.Similarly,specific energy indicates that to produce one kilogram of banana 4.59 MJ.kg^{-1} energy was required which shows poor output rather than input in the farm and indicates that over use of input energyand also energy productivity confirmed that 0.217 kg.MJ^{-1} output was obtained per unit energy which shows that low output energy in banana farms may be due to excessive use of chemical inputs without appropriate management. Since chemical inputs are subsidized in India, farmers are stimulated to apply them without considering its biological and ecological impacts. On the other hand, lack of awareness about the negative impacts of chemical inputs and utilitarian viewpoint of farmers towards agriculture, could be another reason for excessive use of chemical inputs. Energy intensiveness described that one rupee investment in banana provides only 0.68 MJ.Rs^{-1} which shows inefficient level of energy.

Table 4. Energy consumption under different modes

Energy forms	MJ.ac^{-1}	% value
Direct energy	10085.30	19.02
Indirect energy	42926.10	80.97
Renewable	16605.40	31.32
Non-renewable	36405.90	68.67
Total energy input (MJ.ac^{-1})	52955.40	100.00

Finally, net energy is positive and it was 83160 MJ.ac^{-1}. It showed that energy productivity is better than economic productivity which means that economic issue is not important for banana farmers in this study area.This observation could be argued by the statement that overusing of inputs caused increment in energy consumption and lower yield of banana in this region. Based on the results, famers are advised to improve the productivity related operations for gaining better yield.

Energy consumption

Table 4 revealed that share of direct input energy (19.02%) was much lower compared to that of indirect energy (80.97%). Also, non-renewabl e and renewable energies contributed to 68.67% and 31.3% of the total energy input, respectively. It is evident that indirect energy was mostly preferred by banana farmers for increasing their production and usage of more non-renewable energy confirmed that farmers are using more fossil fuels and which may affect the environment and also it contributes for higher production cost. The results are coincides with the studies (Handan, 2011) in banana, (Fadavi *et al.,* 2011) in apple and (Mehmet, 2016) in cotton in terms of various energy forms.

Conclusion

This study utilized an energy analysis to evaluatethe energy use in banana and results revealed that the energyinputs use in banana production was 53011.38 MJ.ac^{-1} and total output energy was 136172 MJ.ac^{-1}. The other parameter such as specific energy was 4.593 MJ.kg^{-1}, energy input-output ratio. The results revealed that the ratio of non-renewable energy (68.67%) is higher than the ratio of renewable energy (31.3%) and also the ratio of indirect energy (80.97%) is higher than ratio of direct energy (19.02%). Due to lack of improved technologies such as mechanization and improved fertilizers techniques presides the more indirect and non-renewable energy usage in banana production and it implies lack in usage of direct and renewable energies. In this study energy management is most important one and there must be improved practices in planting method and also in recommended fertilizer application. Finally the results derived from this study indicated that farmers are advised to use recommended dose of fertilizers and planting by optimum number of suckers for increasing economic productivity rather than energy productivity.

References

Devasenapathy,P., Senthilkumar, G. and P.M. Shanmugam.2009. Energy management in crop production. *Ind.J.Agron.,***54(1)**: 80-90.

Dvoskin, D. 1981. Energy dependent agriculture in Israel. *Energy Agric.,***1**: 131-139.

Fadavi, R., Keyhani, A. and S.S. Mohtasebi. 2010. Estimation of a mechanization index in apple orchard in Iran. *Journal of Agricultural Science*.,**2(4)**: 180–185.

FAO.2016. FAO statistical databases. http://www.fao.org.

Fluck, R.C. 1985. Energy sequestered in repairs and maintenance of agricultural machinery. *Trans. ASAE.,* **28(3):** 738-744.

Handan Akcaoz .2011. Analysis of energy use for banana production: A case study from Turkey. *African Journal of Agri.Research.*,**6(25)**: 5618-5624.

Kaltsas, A.M., Mamolos, A.P, Tsatsarelis, C.A, Nanos, G.D. and K.L. Kalburtji. 2007. Energy budget in organic and conventional olive groves. *Agric. Ecosyst. Environ.,***122(2):** 243-251.

Mani, I., Kumar, P, Panwar, J.S. and K. Kant. 2007. Variation in energy consumption in production of wheat-maize with varying altitudes in Hilly Regions of Himachal Pradesh, *India. Energy.*,**32(12):** 2336-2339.

Mehmet Firat Baran. 2016. Energy efficiency analysis of cotton production in Turkey: A case study for Adiyaman province. *American-Eurasian Jou. Agric. & Envi. Sci.*,**16(2)**: 229-233.

Meul, M., Nevens, F, Reheul, D. and G.Hofman. 2007.

Energy use efficiency of specialized dairy, arable and pig farms in flanders. *Agric. Ecosyst. Environ.*,**119(2)**: 135-144.

Mohammadi, A. and M.Omid. 2010. Economical analysis and relation between energy inputs and yield of greenhouse cucumber production in Iran. *Applied Energy.*, **87(1)**: 191-196.

NHB.2017. Horticultural Statistics at a glance 2017. Horticulture Statistics Division, Government of India.

Ozkan, B., Akcaoz, H. and C.F. Karadeniz. 2004. Energy requirement and economic analysis of citrus production in Turkey. *Energy Conversion Mgt.*,**45(12):** 1812-1830.

Pervanchon, F., Bockstaller, C. and P.Girardinc. 2002. Assessment of energy use in arable farming systems by means of an agro-ecological indicator: the energy indicator. *Agricultural Systems.*,**72(2):** 149–172.

Pimentel, D., Hepperly, P, Hanson, J, Douds, D. and R. Seidel. 2005. Environmental, Energetic and Economic Comparisons of Organic and Conventional Farming Systems. *Bioscience.*,**55(7)**: 573-582.

Reganold, J.P., Glover, J.D, Andrews, P.K. and H.R. Hinman. 2001. Sustainability of three apple production systems. *Nature.*,**410(6831)**: 926-930.

Singh, H., Singh, A.K, Kushwaha, H.L. and A. Singh. 2007. Energy consumption pattern of wheat production in India. *Energy.,***32(10)**: 1848-1854.

Singh, M.K., Pal, S.K, Thakur, R. and U.N. Verma. 1997. Energy input output relationship of cropping systems. *Indian J. Agric. Sci.,* **67 (6)**: 262-264.

Spiertz. and F. Ewert. 2009. Crop production and resource use to meet the growing demand for food, feed and fuel: opportunities and constraints. J*ournal of life Sciences.*,**56(4):** 281-300.

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