Environment and Ecology 41(2B): 1258—1262, April—June 2023
ISSN 0970-0420

Energy Utilization Pattern in Potato Production in Jammu and Kashmir

Sanjay Khar, Obaid Zaffar

Received 12 January 2023, Accepted 25 March 2023, Published on 21 June 2023

ABSTRACT

The aim of this study was to examine the energy use pattern, energy use efficiency and energy productivity for potato production in Jammu of UT of Jammu and Kashmir, India. To achieve these objectives, the data for the production of potatoes produced under Jammu region were collected from 100 potato growing farmers. The data regarding energy inputs in the form of seed, fertilizers, chemicals, irrigation, human, animal and output in the form of yield were collected using pre-tested proforma by a combination of recall method and by taking actual measurements for farmers in the village. The results regarding energy used for various field operations showed that land preparation consumed major energy constituting 34.0 % of the total energy among different operation for production of potatoes. The human source contributed minimum among the other sources. However, the operation of digging and uprooting alone consumed 500 man-hour/ha amounting for more than 45% of human energy. The total energy consumed was estimated as 24890 MJ/ha with energy ratio of 1.80, energy productivity of 0.49 kg/MJ and specific energy of 2.0 MJ/kg. The renewable to non-renewable use of energy was equal i.e., ratio of 1:1 however the usage of renewable energy inputs especially organic manure should be promoted.

Keywords Potato, Energy, Energy ratio, Energy productivity, Specific energy, Energy coefficients.

INTRODUCTION

Potato (*Solanum tuberosum*) is designated as "Food for Future" by FAO (Food and Agriculture Organization) and are grown worldwide under a wider range of climatic conditions than any other major food crop. Initially, it was termed as an important season crop in the hills as well as in plains but now it is being cultivated in almost all the states of India under different agro-climatic conditions. India has progressed significantly in terms of potato area and production since independence. In the year 1949, India used to produce 1.54 million tons of potatoes from 0.234 million ha area at an average productivity level of 6.58 t/ha. The potato production in India during 2019 was 51.31 million tons from 2.14 million ha area with a productivity of 23.95 t/ha (ICAR- 2019). In the Union territory of Jammu and Kashmir, the production of potato has increased to the tune of 83.00% over five-decade time period. The annual production of potato for the UT of Jammu and Kashmir was 0.036 million metric tones for the year 2020-21(DES 2021). The increment in the production area and productivity of potato to meet the increasing demands of the growing population came up with cost of increasing input energy by utilization of inputs like fuel, seed, fertilizers and chemicals. The efficient use of these inputs is vital for increasing the production, produc-

Sanjay Khar[1], Obaid Zaffar[2]*
[1]Professor, [2]PhD Scholar
Division of Farm Machinery and Power Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha-Jammu 180009, J and K, India
Email: obaidzaffar@gmail.com
*Corresponding author

Table 1. Energy equivalents of inputs and outputs in agricultural production.

Energy source (input)	Units	Equivalent energy (MJ)
Human labor	Man-hour	1.96
Bullocks	Pair-hour	10.10
Diesel	Liter	56.31
Petrol	Liter	48.23
Electricity	Kwh	11.93
Fertilizers		
Nitrogen	Kg	60.60
ii) P_2O_5	Kg	11.10
iii) K_2O	Kg	6.70
iv) FYM	Kg	0.30
Machinery		
i) Wooden	Kg	10.43
ii) Metallic	Kg	62.70
Electric motor	Kg	64.80
Water	m^3	0.63
Energy source (Output)	Units	Equivalent energy (MJ)
Cereals	Kg	14.70
Pulses	Kg	14.70
Oil seeds	Kg	25.00
Vegetables		
High food value	Kg	5.6
Medium food value	Kg	3.6
Low food value	Kg	1.6
Potato	Kg	3.6

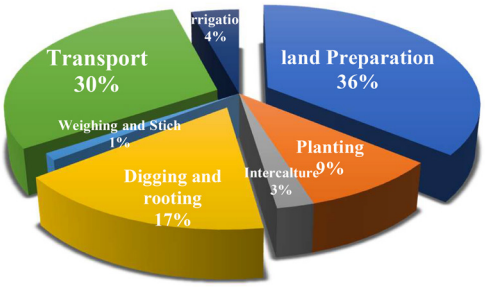

Fig. 1. Operation wise energy used for the cultivation of potato.

tivity and competitiveness of agriculture. The knowledge of energy availability and utilization pattern is one of the most common approaches to examine the energy efficiency and environmental impact of the production system. It enables to calculate output input ratio, relevant indicators, and energy use patterns in an agricultural activity. The UT of Jammu and Kashmir is an agricultural region and the agriculture is in transition from low-energy using methods of farming to more energy-intensive methods. To cope with the food requirement of the states growing population, self-sufficiency in food production is required, which can be achieved through prudent use of the available energy resources (Khar *et al.* 2013). Mohammadi *et al.* (2008) calculated the required energy for potato production in Ardabil and estimated the energy requirements as 87624.96 MJ/ha. The most of energy consumption was related to fertilizer (40%) and diesel (20%) also energy ratio was calculated 1.25. Indirect energy was 82% and direct energy was 18%. Karimi *et al.* (2008) estimated the required energy and energy produced in sugarcane production in Khuzestan as 148.02 and 112.22 GJ/ha respectively. The irrigation

Table 2. Operation wise energy used for the cultivation of potato crop.

Sl. No.	Operation	Tractor	Machinery	Diesel	Human	Total
1	Land preparation	9.72 × 16.416 =159.61	51.10	1973.67	9.72 ×1.96 =19.05	2203.39
2	Planting	1.2 × 16.416 =19.69	136.2 × 0.025 = 3.40	-	181.20 × 1.96 =355.15	561.20
3	Interculture	-	75 × 0.025 = 1.875	-	75.00 × 1.96 = 147.00	148.88
4	Digging and rooting	-	520 × 0.025 = 13.00	-	520.00 × 1.96 = 1019.20	1032.20
5	Weighing and stich	-	-	-	35.6 × 1.96 = 69.77	69.78
6	Transport	9.0 × 16.416 = 147.78	106.59	1348.00	125 × 1.96 = 245.00	1847.34
7	Irrigation	-	-	-	132 × 1.96 = 258.72	258.72
8	Total	327.04	175.97	3504.68	2113.89	6121.58

has the biggest energy consumption from the total input with 43%. Energy used was obtained, 1.59 MJ/kg for per kg of yield. Khar *et al.* (2013) conducted study to determine the energy utilization patter of tomato crop in the erstwhile state of J and K. The results revealed that human labor constituted 65.60% of the total energy served as a chief source of power, while picking, packaging and grading utilized highest operation energy of 2038 MJ/ha. The amount of the commercial and non-commercial energy consumed was 2837 and 6507 MJ/ha respectively. The benefit : Cost ratio was found to be 3.9:1. The study concluded that it was profitable to raise the tomato crop with the available technology and resource utilizations pattern of that time. Only few studies have been conducted in the UT of Jammu and Kashmir so the aim of the study was to estimate energy used and utilization pattern for potato production in Jammu and Kashmir UT of India.

MATERIALS AND METHODS

The study was conducted in four villages namely Makhanpur, Lasswadi, Tarachak and Kotli Mian Fateh of block Bishnah of Jammu district representing the sub-mountain undulating agro-climatic conditions in the UT of J and K. The data was collected from 100 potato growers 25 from each village. The main reasons for selecting these villages were the co-operation of farmers, non-existence of urban effect and the number of farm families thus making a reasonable sample. The energy inputs namely seed, fertilizers, chemicals, irrigation, human, animal and output in the form of yield were collected pre-tested proforma by a combination of recall method and by taking the actual measurements for farmers in the village. The physical data collected in the survey were converted to appropriate energy units by multiplying them with the specific energy coefficients (Singh *et al.* 1998) as given in Table 1. Based on the energy equivalents of the inputs and output (Table 1), the energy ratio (energy use efficiency) and energy productivity were calculated to describe the pattern of energy use for the potato production.

Energy indices

The various energy indices namely energy ratio or efficiency, specific energy and energy productivity were estimated using below given expressions (Alipour *et al.* 2012).

Energy ratio

The energy ratio for the production of the potato was estimated using the expression given as;

$$\text{Energy ratio or efficiency} = \frac{\text{Energy output} \left(\frac{\text{MJ}}{\text{ha}}\right)}{\text{Energy input} \left(\frac{\text{MJ}}{\text{ha}}\right)}$$

Specific energy

The specific energy was calculated using the expression given below :

$$\text{Specific energy} = \frac{\text{Energy input} \left(\frac{\text{MJ}}{\text{ha}}\right)}{\text{Yield} \left(\frac{\text{kg}}{\text{ha}}\right)}$$

Energy productivity

The energy productivity was calculated using the expression given as ;

$$\text{Energy productivity} = \frac{\text{Yield} \left(\frac{\text{kg}}{\text{ha}}\right)}{\text{Energy input} \left(\frac{\text{MJ}}{\text{ha}}\right)}$$

RESULTS AND DISCUSSION

The cultivation of the potato required 1078.5 man-hour/ha accounting for the energy equivalent to

Table 3. Source wise use of energy for potato production.

Sl. No.	Source	Energy (MJ/ha)	Percentage (%)
1	Human	2113.89	8.50
2	Mechanical	4007.70	16.10
3	Fertilizers	8569.00	34.42
4	Seed	10200.00	41.00
5	Total	24890.59	

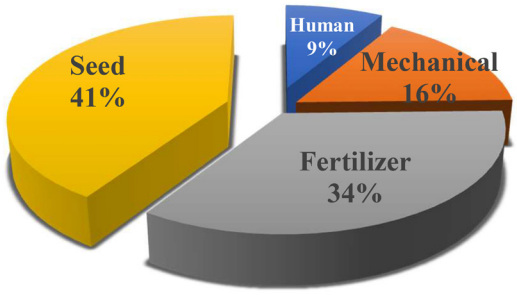

Fig. 2. Source wise use of energy for potato cultivation.

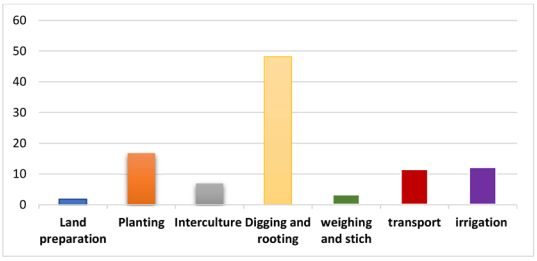

Fig. 3. Utilization pattern human source (man-hour) for different operations of potato cultivation.

2113.89MJ/ha for various operations as shown in Table 2. The energy used in various operations for the cultivation of potato was 6121.58 MJ/ha. The maximum energy was utilized in land preparation (36.0%) followed by transportation and digging and uprooting operation i.e., 30.17 and 16.85% respectively (Fig.1). The minimum energy was consumed in weighing and stiching which contributed 1.14% using 35.5 man-hour/ha. The cultivation of the potato required 24890.59 MJ/ha energy from different sources (Table 3). The requirement of seed alone accounted for the energy of 10200.0 MJ/ha amounting to 40.98% of the total energy (Fig. 2). Energy used in fertilizers was 8569.00 MJ/ha which constituted 34.42 % of the total input energy. The mechanical energy accounted for 4007.70 MJ/ha of energy amounting to 16.10 % of the total energy. The minimum energy in terms of the source was from human which accounted to 2113.89 MJ/ha of energy i.e., only 8.5% of the total energy. The reason for least use of human source in potato cultivation was because most of the energy is used in land preparations and transportation which was done by the use of tractors and other implements.

In terms of human source (man-hour/ha) used in various operation, the digging and uprooting constituted the maximum labor hours (520 man-hour/ha) which accounted for 48.23% of the total of human energy (Fig. 3). Thus, by introducing small portable machinery or tools in a particular operation can lead to decrease man-hour for potato cultivation.

The amount of the commercial and non-commercial energy consumed was 2837 and 6507 MJ/ha respectively (Table 4). The total energy output of the potato crop obtained during the study was 44640 MJ/ha which was nearly to twice the total energy input. The energy ratio observed for the potato crop was 1.80 with an energy productivity 0.49 kg/MJ and specific energy of 2.00 MJ/kg which implies that 2.0 MJ of energy is required to grow 1kg of potatoes. The same were calculated by Hamedani *et al.* (2011) in Iran with total energy consumed in potato production as 92296.3 MJ/ha with energy ratio, energy productivity and specific energy of 1.1, 0.3 and 3.2MJ/ha respectively.

Table 4. Energy sources grouped under different categories of energy (MJ/ha) for cultivation of potatoes.

Sl. No.	Sources	Weighted mean
1	Direct energy	5618.57
2	Indirect energy	19272.00
3	Renewable energy	12313.89
4	Non-renewable energy	12576.69
5	Direct renewable energy	2113.89
6	Direct non-renewable energy	3504.68
7	Indirect renewable energy	10200.00
8	Indirect non-renewable energy	9072.00
9	Commercial energy	2837.00
10	Non-commercial energy	6507.00

CONCLUSION

The total energy required for the production of the potato crop was estimated as 24890 MJ/ha with an energy ratio of 1.80. The maximum energy in terms of the operation wise was consumed in land preparation amounting to 2203.39 MJ/ha or 36% of the total input energy. The production of potato in the study region was highly dependent on the seed and fertilizers constituting about more than 75% energy. Thus,

by using proper seed rate and locally available farm yard manure can result in the decrease of the energy consumption for the production. The human energy was mostly used for digging and uprooting operation which if mechanized can further ease the load of work on the human source. The ratio of the renewable to non- renewable input energy was estimated to 1:1 i.e., both renewable and non-renewable energy were equally used but more emphasis should be laid on using the renewable energy as source of input energy for sustainability of an agriculture.

REFERENCES

Alipour A, Veisi H, Darijani F, Mirbagheri B, Behbahani AG (2012) Study and determination of energy consumption to produce conventional rice of the Guilan province. *Res Agricult Engg* 58(3): 99—106.

DES (2021) Digest of Statistics, Government of Jammu and Kashmir Planning Development and Monitoring Department Directorate of Economics and Statistics, Jammu and Kashmir, pp 106.

Hamedani SR, Shabani Z, Rafiee S (2011) Energy inputs and crop yield relationship in potato production in Hamadan province of Iran. *Energy* 36(5): 2367—2371.

ICAR (2019) Indian Horticulture–Global Potato Conclave. *Ind Council Agricult Res*, *Publisher ICAR* 64(6): 04.

Karimi M, Rajabi PA, Tabatabaeefar A, Borghei A (2008) Energy analysis of sugarcane production in plant farms : A case study in Debel Khazai Agroindustry in Iran. *Am Euras J Agricult Environ Sci* 4(2): 165—171.

Khar S, Sharma P, Sharma N, Sharma R, Choudhary P, Kumar M (2013) Energy utilization pattern in tomato production under dry-land conditions of Jammu and Kashmir (J and K). *Prog Horticult* 45(2): 347.

Mohammadi A, Tabatabaeefar A, Shahin S, Rafiee S, Keyhani A (2008) Energy use and economical analysis of potato production in Iran : A case study Ardabil province. *Energy Conversion Manag* 49(12): 3566—3570.

Singh S, Bakshi R, Singh MP 1(1998) Research digest on energy requirements in agricultural sector in the state of Punjab, FPM/ERAS/88-1, Department of Farm, Power and Machinery, Punjab Agricultural University, Ludhiana.