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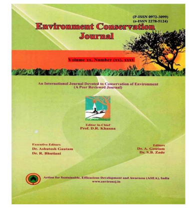

Effect of varying altitudes on energy consumption and wheat production in Himachal Pradesh

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ABSTRACT

A field trial was conducted for the wheat crop at four different altitudes in Himachal Pradesh namely Palampur, Malan, Dhaulakuan and Bajaura. Energy is one of the most important inputs in agricultural production. It is used for farm operations, chemical fertilizers, insecticides, herbicides and is obtained from different renewable and non-renewable sources like diesel/petrol, human labour, animal draught, and electricity. The variation in crop production and energy consumption was determined at various altitudes. The most important set of features responsible for increased wheat yield, technology, input energy, and agro-climatic zone. At location, Bajaura produced the highest output energy (171081.7 MJ/ha) which means maximum grain and straw yield. The maximum energy consumption at Bajaura because of the long spell and good crop health to provide more irrigations required more labour for harvesting and threshing. The Increase in energy inputs enhances the output such as yield, biomass and productivity in different ecosystems. This involves making the most use of available energy inputs to boost output even higher in the key wheat growing regions.

Introduction

Wheat is the world's second-most important cereal crop, after corn and the second most important cereal in India, after rice. Wheat is a key contributor to the food security mosaic. Worldwide, wheat is regarded as the king of grains since it feeds 36 % of the world's population and accounts for 20% of the food calories (Kumar *et al.,* 2013). In India, wheat occupies an area of 31.2 million hectares with a total yield of 96.0 million tonnes and an average production of 31.40 q/ha. Being staple food, in Himachal Pradesh wheat occupied the largest area during 2016-17 when it was grown over an area of 338 thousand hectares with a total production of 650 thousand tonnes with average productivity of 19.21 q/ha (Anonymous 2017). During the production of the crop, energy is one of the most important inputs. Energy is used for a variety of purposes like farm operations, application of chemical fertilizers, insecticides, herbicides and is obtained from different sources like diesel/petrol, human labor, animal draught, and electricity. Due to the population explosion, the

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amount of energy consumption in agriculture has also increased for the production of sufficient food. A developing country like India has a large population of which the majority reside in rural areas and are involved in the agriculture sector. The information of agriculture energy resources and their consumption patterns becomes critical for creating effective food production systems. Increasing the energy inputs enhances yield, crop biomass output and productivity in different ecosystems.

The selection of the source of energy is also very important in sustaining agriculture and reducing the negative impact on the environment. Depletion of non-renewable sources due to the insatiable hunger of humans has led to the energy crisis. Renewable energy can play a critical part in addressing global energy needs or crises. A review of renewable energy technology reveals that enhanced approaches have the potential to cover around half of the US's future energy needs. Another key factor is inefficient energy management in crop production, which can be enhanced by collecting data from field energy consumption and its resources. This will not only aid in the formulation of different policies for enhancement of the crop production but also help in the protection of the environment from the negative effects of excessive and inefficient energy consumption. India has diversified topographic range from vast Gangetic plains to the Thar Desert and coastal regions of south to Himalayas in north. The power availability in Himachal Pradesh is quite low as compared to border sharing states like Punjab and Haryana.

In Himachal Pradesh, there is very diminutive data available on commercial and non-commercial energy availability and use patterns. A study was conducted in which energy–crop yield link was investigated and the variation in crop production energy consumption were determined at various altitudes. High yielding varieties, pesticides, fertilizers and other energy inputs altogether play a role in wheat production, since it is the most widely produced cereal grain on the planet. The most important set of factors responsible for increased wheat yield is energy input, technology and agro-climatic zone. Using a variety of different energy sources which includes renewable, non-renewable power, direct and indirect energy. The eventual input-output ratio is influenced by the energy input and output as yield of each system. Wheat growing has become more vigorous in recent years as Indian cultivation has been switched from human and animal-based production system to a mechanized farming methods. This involves making the most use of available energy inputs to boost output even higher in the key wheat growing regions. The main goal of energy consumption is to raise the output of farms and reduce the input energy as well as the different harmful effects. To achieve this by calculating, analysing and utilization of the energy for wheat production in different wheat growing regions of Himachal Pradesh, taking into account technology, energy input and agro-climatic zones.

Material and Methods

Field experiment was conducted during rabi season at research stations of Department of Agronomy, CSK HPKV, Palampur, Malan, Bajaura and Dhaulakuan in Himachal Pradesh (Table 1) to evaluate the different energy consumption in wheat production with changing altitudes. The different energy input resources are distributed in different categories, like direct, indirect energy, renewable and non-renewable energy. The direct energy source of input in farms i.e., human, water, and diesel were used for different procedures of wheat production, like land preparation, sowing, fertilizer application, weeding, harvesting, threshing, and transportation. Likewise, the indirect form of energy input sources like seed, fertilizers, farmyard manure, weedicides, tractor and implements, were collected for determining the energy consumption as well as economics in production of wheat in the relevance of location. The input energy was compared based on renewable and non-renewable energy. According to the labour usage, operations are listed for the labour requirement per operation and calculated the total usage of direct power in particular operation for the energy requirement (Table 2). The calculation was done in hours of labour-power used in wheat production.

All these energy inputs were multiplied with their respective energy coefficients and the total energy input in crop production was computed. Output energy sources consisted of different products such as grain yield and by-products like straw. The ratio of grains and straw in wheat is 1:1.5. The calculation was done using data of yield per ha and multiplying it with their respective energy equivalents (Table 3). Farmyard manure was transported to the field and spread over the land manually. The land preparation practices involved were ploughing, levelling, bund making and seedbed preparation with tractors and different field implements. The farmyard manure and harvested grains were transported by the tractor. The sowing and fertilizer application were done by spreading manually. After 30 days of sowing, weeding was done by two methods viz. manual weeding and spraying weedicides (Chemical weed control). Harvesting was done manually and threshing was performed by a tractor-operated thresher with the help of labour.

The maximum operations were performed with direct energy i.e., human power as compared to indirect energy i.e., tractor and diesel. Different energy levels of different operations were calculated and the computed input-output energy of the wheat crop was used to study the relationship. To evaluate the different energy-related parameters such as net energy gain, efficiency, total energy, ratio and specific energy the following formulae were used (Mani *et al.,* 2006; Chamsing *et al.,* 2006; Modi *et al.,* 2018).

The energy data available from different direct energy sources of farm energy e.g., human and mechanical and different operations of wheat crop cultivation was collected. Likewise, the data on indirect energy sources were also collected for defining complete energy utilization in the production of wheat crop at different locations.

Total energy invested in complete process is calculated by adding both total direct energy and total indirect energy. Net energy is calculated by subtracting energy output to total input energy (MJ/ha) and ratio is calculated by dividing energy output by total energy input. Specific energy is calculated by dividing the energy input (MJ/ha) by yield (Kg/ha). The experiment was laid out in one sample t test to determine the significant differences between means of energy consumption in crop production in the selected altitudes. The following different energy related efficiency parameters were determined (Mani *et al.,* 2006; Chamsing *et al.,* 2006; Modi *et al.,* 2018).

Total Energy Output (MJ/ha) = (Yield x Energy equivalent) + (Wheat straw x Energy equivalent).

Table 1: Detail of Geographical location of the study area.

SN	Province	Zone	Altitude (m)
	Himachal Pradesh		
1.	Dhaulakuan	I	411
2.	Malan	II	1109
3.	Palampur	II	1291
4.	Bajaura	III	1074

Table 2: Labour Used in different operations of wheat production (MJ).

Operation (Human Power)	Labour Man-hours	Machine Operator Machine-hours	Total
Land preparation	8	8	16
Sowing	80	-	80
FYM transportation and spreading	160	-	160
Application of fertilizers (urea, SSP, MOP)	64	-	64
Weeding and intercultural operation	200	-	200
Application of weedicide	16	-	16
Harvesting	120	-	120
Threshing	40	5	45
Cleaning	50	-	50
Transportation	4	4	8

Table 3: Energy equivalents for various sources of input energy (Jat *et al.,* (2020); Modi *et al.,* (2018); Parveen *et al.,* (2020); Mani *et al.,* (2007)).

Direct and Indirect Energy Input	Units	Energy equivalent (MJ/unit)
Labour	Man-hour	1.96
Diesel	litres	56.31
Seeds/yield seeds	Kg	13.47
Straw	Kg	12.5
FYM	Kg	0.30
Urea	Kg	27.88
Nitrogen	Kg	60.0
MOP	Kg	11.1
SSP	Kg	6.7
Herbicide	Kg	254.45

Results and Discussion

Amongst all locations, Bajaura consumed more energy i.e., 20880.16 (MJ/ha) for wheat production. The total energy consumed in Palampur, Malan, Dhaulakuan was recorded as 20385.4, 20431.6, 20326.8 and 20880.2 MJ/ha respectively (Table 4). This may be due to low rainfall at Dhaulakuan and Bajaura, the number of irrigations was more as compared to Palampur and Malan. So, the input energy of irrigation, harvesting and threshing were at Dhaulakuan and Bajaura as compared to other locations. The basic and standard treatment processes for wheat sowing at the different locations were the same but area-based conditions were different with altitudes like irrigation, weeding and transportation. So, proper management of natural or rain water streams which were suggested for optimum energy use too enhances the crop output. Maximum output energy (Table 5) was obtained at location Bajaura (171081.7 MJ/ha) and lowest at Palampur (134215.1 MJ/ha) and at Malan (148787.4 MJ/ha) and Dhaulakuan (160174.3 MJ/ha) per hectare energy was obtained. The highest net output return (energy) at location Bajaura because the grain and straw produced is maximum (171081.7 MJ/ha) (Table 6 and Figure 1). This may be due to wheat grain yield which was recorded to be highest (5110 kg/ha) and at Palampur, the grain yield was (3830 kg/ha) recorded lowest.

Table 4: Energy input (MJ/ha) for wheat production in different locations of H.P.

OPERATIONS	Dhaulakuan	Malan	Palampur	Bajaura
Zone	**I**	**II**	**III**	**IV**
Land (ha)	1	1	1	1
Source of power	TRACTOR	TRACTOR	TRACTOR	TRACTOR
Land Preparation	921.4	921.4	921.4	921.4
Sowing	156.8	156.8	156.8	156.8
Energy of Operator	15.7	15.7	15.7	15.7
Seed	1347	1347	1347	1347
Irrigation	648	400	320	467
Weeding by Manually	109.8	125.4	125.4	156.8
Herbicide	591.1	591.1	591.1	591.1
Fertilizer	10661.4	10661.4	10661.4	10661.4
Application of Fertilizer	125.4	125.4	125.4	125.4
FYM	3000	3000	3000	3000
Transportation & application of FYM	466.4	632.2	707.1	962.1
Harvesting	203.8	250.9	219.5	266.6
Threshing	2313.2	2313.2	2313.2	2313.2
Transport	291.8	370.2	300.5	420.5
Total input energy	**20851.8**	**20910.7**	**20804.5**	**21405.2**

Table 5: Total Energy output (MJ/ha) relation for wheat in different locations of H.P.

OPERATIONS	Dhaulakuan	Malan	Palampur	Bajaura
Output energy of grain yield	63174.3	59537.4	51590.1	68831.7
Output energy of straw yield	97000	89250	82625	102250
Total output energy	160174.3	148787.4	134215.1	171081.7

Table 6: Net energy, Energy ratio, Specific energy relation for wheat in different locations of H.P.

OPERATIONS	Dhaulakuan	Malan	Palampur	Bajaura
Net Energy	139322.475	127876.64	113411.1	149676.7
Energy Ratio	7.68	7.12	6.45	8.0
Specific Enegy	0.33	0.35	0.40	0.31

Conclusion

From this research, it is concluded that higher the energy input more will be the output (grains and straw). The yield varies with increase in altitude and there is a direct relation among energy consumption and crop productivity. The data required for results was obtained from different energy sources on the basis of utilization. The maximum use of energy was at location Bajaura

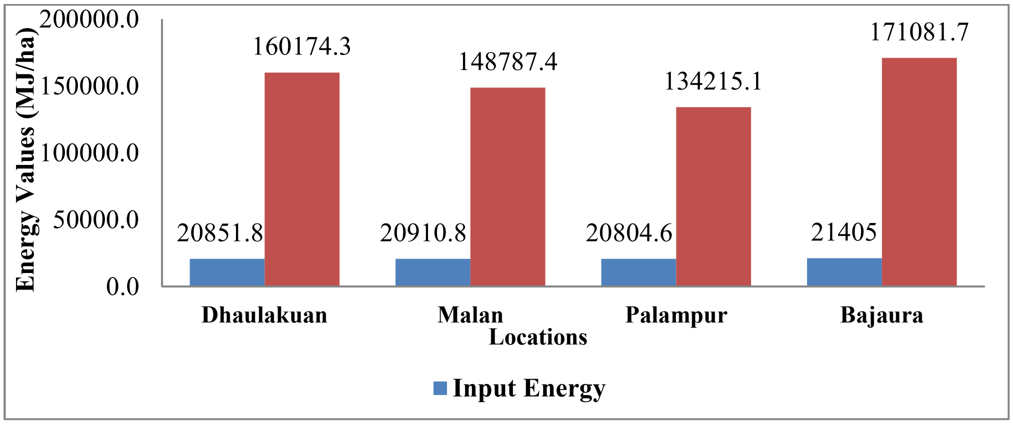

Figure 1: Graph between energy input and output.

because the long spell, good crop health to provide more number of irrigations required more labour for harvesting, threshing and more crop yield.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Ashraf, M. N., Mahmood, M. H., Sultan, M., Banaeian, N., Usman, M., Ibrahim, S. M., Butt, M. U. B. U., Waseem, M., Ali, I., Shakoor, A., & Khan, Z. M. (2020). Investigation of Input and Output Energy for Wheat Production: A Comprehensive Study for Tehsil Mailsi (Pakistan). *Sustainability,* 12, 6884.

Chaudhary, V. P., Gangwar, B., & Pandey, D. K. (2006). Auditing of Energy Use and Output of Different Cropping Systems in India. *Agricultural Engineering International: the CIGR Ejournal,* 3, Manuscript EE 05 001.

Chaudhary, V. P., Gangwar, B., Pandey, D. K., & Gangwar, K. S., (2009). Energy auditing of diversified rice-wheat cropping system in Indo-gangetic plains. *Energy, 34*(9), 1091-1096.

Chilur, R., & Yadachi, S., (2017). Energy Audit of Maize Production System of Selected Villages of North Karnataka, India. *International Journal Current Microbiology and Applied Science, 6*(8), 3564-3571.

Jat, H. S., Jat, R. D., Nanwal, R. K., Lohan, S. K., Yadav, A. K., Poonia, T., Sharma, P. C., & Jat, M. L. (2020). Energy use efficiency of crop residue management for sustainable energy and agriculture conservation in NW India. *Renewable Energy, 155,* 1372-1382.

Modi, R. U., Ali, M., Parmar, R. P., & Namdev, S. K., (2018). Energy Audit Application for Rice-Wheat Cropping System. *Oriental Journal of Computer Science and Technology, 11*(4), 209-218.

Mani, I., Kumar, P., Panwar, J. S., & Kant, K., (2007). Variation in energy consumption in production of wheat–maize with varying altitudes in hilly regions of Himachal Pradesh, India. *Energy, 32,* 2336–2339.

Nassir, A. J., Ramadhan, M. N., & Alwan, A. A. M. (2021). Energy Input-Output Analysis in Wheat, Barley and Oat Production. *Indian Journal of Ecology, 48*(1), 304-307.

Parveen., Singh, A., & Dogra, R. (2020). Energy requirement for the sowing of wheat after the in-situ management of paddy residues. *International Journal of Agricultural Engineering, 13*(1), 10-18.

Singh, H., Singh, A. K., Kushwaha, H. L., & Singh, A. (2007). Energy consumption pattern of wheat production in India. *Energy, 32,* 1848–1854.

Singh, G., Singh, P., Sodhi, G. P. S., & Tiwari, D. (2021). Energy auditing and data envelopment analysis (DEA) based optimization for increased energy use efficiency in wheat cultivation (*Triticum aestium*L.) in north-western India. *Sustainable Energy Technologies and Assessments, 47,* 101453.

Saad, A. A., Das, T. K., Rana, D. S., Sharma, A. R., Bhattacharyya, R., & Lal, K. (2016). Energy auditing of a maize wheat green gram cropping system under conventional and conservation agriculture in irrigated north-western Indo-Gangetic Plains. *Energy, 116,* 293-305.

Singh, P., Benbi D. K., & Verma, G., (2020). Nutrient Management Impacts on Nutrient Use Efficiency and Energy, Carbon, and Net Ecosystem Economic Budget of a Rice–Wheat Cropping System in Northwestern India. *Journal of Soil Science and Plant Nutrition, 21,* 559–577.