



Review Paper

## Comparative analysis of energy consumption in agriculture of Haryana, India

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### Abstract

The prime objective of the present research study is to analyze the district-wise structure of energy consumption in agriculture of Haryana during 2012-13. Data related to the study were collected from Statistical Abstract of Haryana, published by Department of Economic and Statistical Analysis (DESA), Government of Haryana. Energy consumption in k.cal./hect./annum has been computed with the help of total cropped area and Standard Energy Conversion Table prepared by TERI. Data analysis showed that the average energy consumption in the state was 27, 34,157.27 k.cal./hect./annum. About 90% of the total energy consumption comes from chemical energy followed by human energy (7%), electrical energy (1.7%) and mechanical energy (1.3%). Kurukshetra, Yamunanagar, Palwal, Karnal and Panipat districts of the state have consumed the high amount of energy whereas Bhiwani, Jhajjar, Mahendragarh and Panchkula district have consumed the low amount of energy. Ambala, Rohtak, Rewari, Jind and Fatehabad district have consumed the moderate quantity of energy in agriculture of the state.

**Keywords:** Energy, Agriculture, Total Cropped Area, Chemical Energy, Mechanical Energy and Human Energy.

### Introduction

Energy is a key input of agriculture in terms of crop production<sup>1,2</sup>. Structural pattern of energy consumption in agriculture primarily depend on crop season, farming system, technological development and agro-climatic conditions<sup>3</sup>. Energy has been playing a considerable role in the growth and development of agriculture in Haryana state since its formation. 'Green Revolution' has brought significant structural changes in the consumption of energy inputs in agriculture of the state, with a major budge from the animal and human energy (animate energy) towards to chemical fertilizers, pesticides, high yield variety of seeds, diesel, electricity and advanced machines. It has also increased the level of total consumption of commercial energy in agriculture of the state<sup>4,5</sup>. Agriculture is the prime mover and backbone of Haryana's economy with significant contribution to its Gross Domestic Product (GDP) and largest source of occupation to people of the state. The agriculture has almost achieved the saturation level with about eighty percent area of total geographical area of the state under crop cultivation of which about eighty four percent is irrigated. Haryana is the highly agricultural developed state in India with high agricultural productivity and crop intensity of 184 percent. Though, geographically, it is one of the smallest states in India but it is the second highest contributor to the national food basket in present time<sup>6-8</sup>.

Haryana together with its bordering Punjab state is called as the "Grain Bowl of India"<sup>9</sup>.

### Methodology

The present study basically depends upon the secondary data which has been collected from Statistical Abstract of Haryana, published by Department of Economic and Statistical Analysis (DESA), Government of Haryana. The data have been collected for total cropped area, fertilizers consumption, number of diesel pump sets, electric pump sets, tractor and agricultural workers at district level. Then, energy input per hectare has been calculated by dividing the total energy inputs in the district by the total cropped area of the same district. Thereafter, energy consumption in kilo calorie per hectare/annum of each selected energy inputs have been computed with the help of standard energy conversion table which given by The Energy Resources and Institute-TERI<sup>10</sup> (Table-1). The 'total cropped area' represents the total sown area once and more than once in an agricultural year. This area also called gross cropped area or total sown area<sup>11</sup>. The total cropped area varies from district to district in agriculture of Haryana (Table-2).

### Results and discussion

**Chemical Energy:** In the process of crop cultivation, 'chemical energy' refers to the use of artificial agricultural nutrients such as nitrogen, phosphate, potassic, pesticides and other superior chemicals. Chemical fertilizers are vital macro nutrients for crop production<sup>12</sup>. The consumption of chemical energy varies at district level in agriculture of Haryana (Table-3). The total utilization of chemical energy in the state was 5,21,41,447.00

k.cal./hect/annum while the average consumption was 24,82,926.05 k.cal./hect./annum during 2012-13. Kurukshetra district of the state has consumed largest amount of chemical energy (41,03,756.50 k.cal./hect./annum) whereas Bhiwani district consumed lowest amount (9,70,829.75 k.cal./hect./annum) of the same energy. Ambala, Yamunanagar, Kaithal, Karnal, Sonipat, Panipat, Rohtak, Palwal, Rewari, Jind and Fatehabad districts have consumed total chemical energy above the state average (24,82,926.05 k.cal./hect./annum) while Panchkula, Jhajjar, Faridabad, Gurgaon, Mewat, Mahendragarh, Hisar and Sirsa districts consumed the same energy below the state average.

**Table-1:** Energy Equivalents for Different Energy Inputs.

Category	Energy Equivalents
Man	470 K.Cal./hr
Tractor (30 hp)	19,230 K.Cal./hr
Electric tube well (20 hp)	12,820 K.Cal./hr
Diesel Pump Set (7.5 hp)	4,807.5 K.Cal./hr
Nitrogen (Fertilizer)	14,325 K.Cal./kg
Phosphate (Fertilizer)	2,650 K.Cal./kg
Potash(Fertilizer)	1,600 K.Cal./kg

Source: The Energy and Resources Institute, 1987.

**Table-2:** District-wise Total Cropped area in Haryana, 2012-13.

District	Total Cropped Area ('000' Hect.)	District	Total Cropped Area ('000' Hect.)
Ambala	206	Palwal	190
Panchkula	44	Gurgaon	105
Yamunanagar	211	Mewat	156
Kurukshetra	265	Rewari	182
Kaithal	385	Mahendragarh	285
Karnal	389	Bhiwani	711
Panipat	190	Jind	470
Sonipat	286	Hisar	631
Rohtak	227	Fatehabad	427
Jhajjar	225	Sirsa	726
Faridabad	65	Haryana (Total)	6,376

Source: Statistical Abstract of Haryana, 2015, DESA, Government of Haryana.

Nitrogenous has supplied the bulk amount of energy followed by phosphatic and potassic in agriculture of each district of the state. The total consumption of nitrogenous fertilizer was 4,91,37,328.50 k.cal./hect./annum in the state while the average use was 23,39,872.79 k.cal./hect./annum (163.34 kgs./hect./annum) in 2012-13.

The total use of potassic was 1,02,448.00 k.cal./hect./annum while the average was 4,878.48 k.cal./hect./annum (3.05 kgs./hect./annum). The total consumption of phosphatic in the state was 2,901,670.50 k.cal./hect./annum with the average use of 1,38,174.79 k.cal./hect./annum (52.14 kgs./hect./annum). Kurukshetra district has consumed the highest amount of nitrogenous energy amounting 39,42,240.00 k.cal./hect./annum (275.20 kgs./hect./annum) while Bhiwani district has consumed the lowest quantity of the same energy amounting to 9,00,899.25 k.cal./hect./annum (62.89 kgs./hect./annum). Yamunanagar, Palwal and Karnal districts stand at second, third and fourth position from the top in terms of nitrogenous energy consumption amounting to 35,86,693.50 k.cal./hect./annum (250.38 kgs./hect./annum), 34,75,101.75 k.cal./hect./annum (242.59 kgs./hect./annum) and 32,13,240.75 k.cal./hect./annum (224.31 kgs./hect./annum) respectively.

Palwal district has consumed the highest amount of phosphatic energy in the state amounting to 2,18,916.50 k.cal./hect./annum (82.61 kgs./hect./annum). Ambala, Yamunanagar, Kurukshetra, Kaithal, Karnal, Sonipat, Panipat, Rohtak, Faridabad, Gurgaon, Rewari and Fatehabad districts have consumed more phosphatic energy as compare to Jhajjar, Jind, Sirsa, Hisar and Mewat Districts of the state.

Spatial variations are also found in the use of potassic energy consumption from 544.00 k.cal./hect./annum (0.34 kg./hect./annum) in Jhajjar district to 15,360.00 k.cal./hect./annum (9.60 kgs./hect./annum) in Palwal district.

**Mechanical Energy:** In agricultural production system, 'mechanical energy' defined as the use of various machines, instruments and other valuable agricultural implements such as tractor, diesel pump sets, thresher, harvester combine, reapers, seed drills, tillers, disc harrow, and sprayers etc. The total consumption of mechanical energy in the state was 6,10,545.77 k.cal./hect./annum having average of 29,073.61 k.cal./hect./annum in 2012-13 (Table-4).

The highest consumption of mechanical energy has found in Panchkula district amounting to 1,07,324.56 k.cal./hect./annum whereas the lowest registered in Mahendragarh district amounting to 7,847.29 k.cal./hect./annum. Yamunanagar, Sonipat, Rohtak, Jhajjar, Faridabad and Palwal districts have consumed the mechanical energy above the state average (29,073.61 k.cal./hect./annum) while Ambala, Kurukshetra, Kaithal, Karnal, Panipat, Gurgaon, Rewari, Mewat, Bhiwani, Jind, Fatehabad and Sirsa districts consumed same energy below the state average.

**Table-3:** Consumption of Chemical Fertilizers/Chemical Energy in Haryana, 2012-13.

District	Nutrients in Kgs./hect./annum			Energy Consumption in K.Cal./hect./annum			
	Nitrogenous	Phosphatic	Potassic	Nitrogenous	Phosphatic	Potassic	Total
Ambala	191.61	55.54	3.45	27,44,813.25	1,47,181.00	5,520.00	28,97,514.25
Panchkula	78.84	45.57	1.18	11,29,383.00	1,20,760.50	1,888.00	12,52,031.50
Yamunanagar	250.38	62.48	5.67	35,86,693.50	1,65,572.00	9,072.00	37,61,337.50
Kurukshetra	275.20	57.17	6.26	39,42,240.00	1,51,500.50	10,016.00	41,03,756.50
Kaithal	199.53	54.21	3.53	28,58,267.25	1,43,656.50	5,648.00	30,07,571.75
Karnal	224.31	63.57	1.82	32,13,240.75	1,68,460.50	2,912.00	33,84,613.25
Panipat	223.22	56.23	1.78	31,97,626.50	1,49,009.50	2,848.00	33,49,484.00
Sonipat	211.51	55.12	1.89	30,29,880.75	1,46,068.00	3,024.00	31,78,972.75
Rohtak	176.70	56.48	0.81	25,31,227.50	1,49,672.00	1,296.00	26,82,195.50
Jhajjar	75.12	36.85	0.34	10,76,094.00	97,652.50	544.00	11,74,290.50
Faridabad	122.54	54.69	4.40	17,55,385.50	1,44,928.50	7,040.00	19,07,354.00
Palwal	242.59	82.61	9.60	34,75,101.75	2,18,916.50	15,360.00	37,09,378.25
Gurgaon	101.76	56.21	3.51	14,57,712.00	1,48,956.50	5,616.00	16,12,284.50
Mewat	98.40	32.76	0.76	14,09,580.00	86,814.00	1,216.00	14,97,610.00
Rewari	175.24	81.19	7.22	25,10,313.00	2,15,153.50	11,552.00	27,37,018.50
Mahendragarh	75.18	30.92	1.40	10,76,953.50	81,938.00	2,240.00	11,61,131.50
Bhiwani	62.89	25.29	1.82	9,00,899.25	67,018.50	2,912.00	9,70,829.75
Jind	170.04	46.72	1.30	24,35,823.00	1,23,808.00	2,080.00	25,61,711.00
Hisar	133.84	43.37	1.75	19,17,258.00	1,14,930.50	2,800.00	20,34,988.50
Fatehabad	192.93	51.78	2.88	27,63,722.25	1,37,217.00	4,608.00	29,05,547.25
Sirsa	148.35	46.21	2.66	21,25,113.75	1,22,456.50	4,256.00	22,51,826.25
Total Haryana	3,430.18	1,094.97	64.03	4,91,37,328.50	29,01,670.50	1,02,448.00	5,21,41,447.00
State Average	163.34	52.14	3.05	23,39,872.79	1,38,174.79	4,878.48	24,82,926.05

Source: Statistical Abstract of Haryana, 2014, DESA, Government of Haryana.

**Table-4:** Use of Machineries/Mechanical Energy in Haryana, 2012-13.

District	Tractor No./hec./ annum	Energy Consumption in K.Cal./hect./ annum	Diesel Pump Set No./hect./ annum	Energy Consumption in K.Cal./hect./ annum	Total Energy Consumption in K.Cal./hect./ annum
Ambala	0.04	15,468.61	0.02	4,519.05	19,987.66
Panchkula	0.26	1,00,545.98	0.03	6,778.58	1,07,324.56
Yamunanagar	0.06	23,202.92	0.03	6,778.58	29,981.50
Kurukshetra	0.05	19,335.77	0.03	6,778.58	26,114.35
Kaithal	0.03	11,601.46	0.05	11,297.63	22,899.09
Karnal	0.05	19,335.77	0.0005	112.98	19,448.75
Panipat	0.01	3,867.15	0.02	4,519.05	8,386.20
Sonipat	0.06	23,202.92	0.07	15,816.68	39,019.60
Rohtak	0.06	23,202.92	0.05	11,297.63	34,500.55
Jhajjar	0.07	27,070.07	0.09	20,335.73	47,405.80
Faridabad	0.06	23,202.92	0.04	9,038.10	32,241.02
Palwal	0.08	30,937.22	0.08	18,076.20	49,013.42
Gurgaon	0.05	19,335.77	0.01	2,259.53	21,595.30
Mewat	0.03	11,601.46	0.05	11,297.63	22,899.09
Rewari	0.05	19,335.77	0.03	6,778.58	26,114.35
Mahendragarh	0.02	7,734.31	0.0005	112.98	7,847.29
Bhiwani	0.03	11,601.46	0.03	6,778.58	18,380.04
Jind	0.03	11,601.46	0.04	9,038.10	20,639.56
Hisar	0.03	11,601.46	0.03	6,778.58	18,380.04
Fatehabad	0.04	15,468.61	0.02	4,519.05	19,987.66
Sirsa	0.03	11,601.46	0.03	6,778.58	18,380.04
Haryana (Total)	1.14	4,40,855.44	0.75	1,69,690.33	6,10,545.77
State Average	0.05	20,993.12	0.04	8080.49	29,073.61

Source: Statistical Abstract of Haryana, 2014, DESA, Government of Haryana.

Tractors have produced more energy as compare to diesel pump sets in agriculture of each district of the state. The total energy produced by tractors in the state was 4,40,855.44 k.cal./hect./ annum with an average use of 20,993.12 k.cal./hect./annum (0.05 tractor/hect./annum) in 2012-13. Panchkula district has

used more tractors i.e. 0.26 tractors/hect./annum amounting to 1,00,545.98 k.cal./hect./annum in 2012-13 while Panipat registered the less use of tractors i.e. 0.01 tractor/hect./annum amounting to 3867.15 k.cal./hect./annum. Yamunanagar, Sonipat, Rohtak, Jhajjar, Palwal, Faridabad districts have used

more tractors in agricultural operations than Yamunanagar, Kurukshetra, Kaithal, Karnal, Gurgaon, Mewat, Rewari, Bhiwani, Jind, Hisar and Sirsa districts of the state. The total energy produced by diesel pump sets in the state was 1,69,690.33 k.cal./hect./annum with an average use of 8,080.49 k.cal./hect./annum in 2012-13. Jhajjar district has used more diesel pump sets i.e. 0.09 diesel pump set /hect./annum amounting to 20,335.73 k.cal./hect./annum while Karnal and Mahendragarh district have used 0.0005 diesel pump set/hect./annum amounting to 112.98 k.cal./hect./annum. Kaithal, Rohtak, Sonipat and Mewat district have used more diesel pump sets in irrigation operation as compare to Ambala, Panipat, Gurgaon and Fatehabad districts of the state.

**Human energy:** Human energy is the back bone of agriculture, without it the process of agriculture cannot be possible in any region of the world. Almost, each agricultural operation is completed by human efforts. Although, human labour has declined with the introduction of technology in the field of agriculture yet it is still important for the upliftment of agriculture. The total use of human energy in the state was 39,96,118.60 k.cal./hect./annum while the average use of human energy at district level was 1,90,291.36 k.cak./hect./annum in 2012-13 (Table 5). Gurgaon district has used highest amount of human energy amounting to 3,93,907.00 k.cal./hect./annum (1.15 workers/hect./annum). Mewat, Panchkula, Faridabad and Sonipat district have consumed 2,77,093.20 k.cal./ hect./annum

(1.02 workers/hect.); 2,44,494.00 k.cal./hect., (0.90 worker/hect./annum), 2,39,060.80 k.cal./hect./annum (0.88 worker/hect./annum) and 2,30,911.00 k.cal./hect./ annum (0.85 worker/hect./annum) respectively. Sirsa district has used the lowest human energy amounting to 1,16,813.80 k.cal./hect./annum. Ambala, Yamunanagar, Kurukshetra, Kaithal, Karnal, Rohtak, Palwal, Mahendragarh, Bhiwani, Hisar, Fatehabad districts of the state have used human energy below the state average (1,90,291.36 k.cak./hect./annum).

**Electrical energy:** The role of electricity is continuously increasing in agricultural sector due to limited storage of diesel. The total consumption of electrical energy in agriculture of the state was 6,69,191.31 k.cal./hect, with an average consumption of 31,866.25 k.cal./hect./annum, (0.09 pump set/ hect./annum) during 2012-13 (Table-6). The highest amount of electrical energy was consumed in Kurukshetra district amounting to 90,284.85 k.cal./hect./annum (0.25 pump set/hect./annum) whereas the lowest electricity consumption was recorded in Rohtak district having 3,611.39k.cal./hect./annum (0.01 pump set/hect./annum). Ambala, Panipat, Rewari, Faridabad, Panchkula, Yamunanagar, Kaithal, Karnal, Panipat, Faridabad, Rewari, Mahendragarh, consumed the electrical energy above the state average (31,866.25 k.cal./hect./annum). Rohtak, Jhajjar, Palwal, Gurgaon, Mewat, Bhiwani, Jind, Hisar, Fatehabad, Sirsa used the electric energy below the state average.

**Table-5:** Use of Agricultural Workers/Human Energy in Haryana, 2012-13.

District	Agricultural Workers/ hect./annum	Human Energy in K.Cal./hect./ annum	District	Agricultural Workers/hect./ annum	Human Energy in K.Cal./hect./ annum
Ambala	0.53	1,43,979.80	Gurgaon	1.45	3,93,907.00
Panchkula	0.90	2,44,494.00	Mewat	1.02	2,77,093.20
Yamunanagar	0.64	1,73,862.40	Rewari	0.72	1,95,595.20
Kurukshetra	0.58	1,57,562.80	Mahendragarh	0.66	1,79,295.60
Kaithal	0.55	1,49,413.00	Bhiwani	0.55	1,49,413.00
Karnal	0.63	1,71,145.80	Jind	0.71	1,92,878.60
Panipat	0.71	1,92,878.60	Hisar	0.64	1,73,862.40
Sonipat	0.85	2,30,911.00	Fatehabad	0.54	1,46,696.40
Rohtak	0.58	1,57,562.80	Sirsa	0.43	1,16,813.80
Jhajjar	0.70	1,90,162.00	Haryana (Total)	14.71	39,96,118.60
Faridabad	0.88	2,39,060.80	State Average	0.70	1,90,291.36
Palwal	0.44	1,19,530.40			

Source: Statistical Abstract of Haryana, 2014, DESA, Government of Haryana.

**Table-6:** Consumption of Electrical Energy in Haryana, 2012-13

District	Electric Pump Set no./ hect./ annum	Electrical Energy in K.Cal./hect./ annum	District	Electric Pump Set no./hect./ annum	Electrical Energy in K.Cal./hect./ annum
Ambala	0.11	39,725.33	Gurgaon	0.02	8,306.21
Panchkula	0.09	32,502.55	Mewat	0.05	18,056.97
Yamunanagar	0.13	46,948.12	Rewari	0.16	57,782.30
Kurukshetra	0.25	90,284.85	Mahendragarh	0.10	36,113.94
Kaithal	0.12	43,336.73	Bhiwani	0.04	14,445.58
Karnal	0.11	39,725.33	Jind	0.07	25,279.76
Panipat	0.16	57,782.30	Hisar	0.02	7,222.79
Sonipat	0.08	28,891.15	Fatehabad	0.07	25,279.76
Rohtak	0.01	3,611.39	Sirsa	0.05	18,056.97
Jhajjar	0.03	10,834.18	Haryana (Total)	1.85	6,69,191.31
Faridabad	0.13	46,948.12	State Average	0.09	31,866.25
Palwal	0.05	18,056.97			

Source: Statistical Abstract of Haryana, 2014, DESA, Government of Haryana.

**Table-7:** Total Energy Consumption in Agriculture of Haryana, 2012-13

District	Total Energy in K.Cal./hect./annum	District	Total Energy in K.Cal./hect./annum
Ambala	31,01,207.05	Gurgaon	20,36,093.00
Panchkula	16,36,352.60	Mewat	18,15,659.25
Yamunanagar	40,12,129.52	Rewari	30,16,510.34
Kurukshetra	43,77,718.49	Mahendragarh	13,84,388.32
Kaithal	32,23,220.56	Bhiwani	11,53,068.36
Karnal	36,14,933.13	Jind	28,00,508.92
Panipat	36,08,531.11	Hisar	22,34,453.72
Sonipat	34,77,794.50	Fatehabad	30,97,511.07
Rohtak	28,77,870.24	Sirsa	24,05,077.05
Jhajjar	14,22,692.48	Total Haryana	5,74,17,302.68
Faridabad	22,25,603.94	State Average	27,34,157.27
Palwal	38,95,979.04		

Source: Statistical Abstract of Haryana, 2014, DESA, Government of Haryana.

**Level of Total Energy Consumption in Haryana's Agriculture:** Apart from above analysis, the total energy use (k.cal./hect./annum) in agriculture of Haryana has been calculated by adding the all selected energy inputs/sources i.e. chemical, mechanical, human and electrical energy. It was found that the level of total energy consumption in the state also varies from district to district. The total energy use in agriculture of the state was 57,417,302.68 k.cal./hect./annum with an average value of 27,34,157.27 k.cal./hect./annum during 2012-13 (Table-7). The highest level of total energy consumption was found in Kurukshetra district having 43,77,718.49 k.cal./hect./annum., followed by Yamunanagar (40,12,129.52 k.cal./hect./annum) and Palwal (38,95,979.04 k.cal./hect./annum). Bhiwani district has consumed the lowest amount of total energy with a value of 11,53,068.34 k.cal./hect./annum. Ambala, Panipat, Sonapat, Rohtak, Kaithal, Karnal, Rewari, Jind and Fatehabad districts of the state have consumed total energy above the state average (27,34,157.27 k.cal./hect./annum) whereas Panchkula, Jhajjar, Gurgaon, Mewat, Mahendragarh and Sirsa district consumed total energy below the state average.

## Conclusion

The present study observed that there are lots of structural and spatial variations in the pattern of energy consumption in agriculture of the state. Chemical energy was recorded as the major source of energy followed by human, electrical and mechanical energy. Kurukshetra, Yamunanagar, Palwal, Karnal and Panipat districts of the state have consumed the high quantity of energy whereas Bhiwani, Jhajjar, Mahendragarh and Panchkula district have consumed the low quantity of energy. Ambala, Rohtak, Rewari, Jind and Fatehabad district have consumed the moderate quantity of energy. Therefore, it can be stated that there is wide scope for backward/low energy consuming districts to increase the level of energy consumption specially electrical and mechanical energy in agriculture.

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