R.S. Yadav, N.K.Khandelwal / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 3, May-Jun 2013, pp.531-536

Effect of variousEnergy inputs on Energy requirement for Wheat Production in Agro-Climatic Region (Kamore plateau and Satpura Hill), M.P. India.

R.S. Yadav*, N.K.Khandelwal**

* M.Tech student and ** Associate Professor,Deptt.of Farm Machinery and Power Engineering, College of Agricultural Engineering, JNKVV, Jabalpur (M.P.)

ABSTRACT

Energy in agriculture is important in terms of crop production and agro processing for value adding. The energy requirement in various facets of agriculture varies considerably due to variation in the technology level adopted by the farmers and also because of the diverse agro-climatic conditions. The increased use of inputs such as fertilizer, irrigation water, diesel, plant protection chemicals, electricity etc. demands more energy in the form of human, animal and machinery. The aims of this study were to determine direct input energy and indirect energy in Kamore plateau and Satpura HillRegion,which belongs to wheat-rice zone of Madhya Pradesh, to investigate the efficiency of energy consumption. Data were collected from 120 farmer of Agro-Climatic Region by using a face to face questionnaire method. The results revealed that wheat production in year of 2010-11 consumed a total of 14345MJ/ha of which chemical fertilizer, diesel fuel and electric energy consumption was 31.1%, 20.5% and 24.2%, respectively. Direct and Indirect energy were 49.6% and 50.4% respectively. Output Energy was 56595 MJ/ha. Output– input energy ratio and specific energy of production and productivity were 3.9, 3.7 MJ/kg and 0.27 kg/MJ, respectively. The use of commercial source is too high as compared to non-commercial energy sources. Commercial sources contributed about 93.4 per cent of total energy (14345 MJ/ha).On the basis of linear programming the prediction of energy requirement for different levels of yield reveals that there exist a significant scope to enhance wheat productivity through increased use of input energy through fertilizer and machinery. This is mainly due to the reason that still agricultural farms of Madhya Pradesh are applying 50-75% of recommendation of fertilizer and machinery use.

Keyword: Wheat, Energy ratio, Specific Energy, Yield, Productivity.

1. Introduction

Energy has an influencing role in the development of key sectors of economic importance such as industry, transport and agriculture. This has motivated many researchers to focus their research onenergy management. Energy has been a key input of agriculture since the age of subsistence agriculture. It is an established fact worldwide that agricultural production is positively correlated withenergy input (Singh, 1999). Agriculture is both a producer and consumer of energy. It uses large quantities of locally available noncommercial energy, such as seed, manure and animate energy, as well as commercial energies, directlyand indirectly, in the form of diesel, electricity, fertilizer, plant protection, chemical, irrigation water, machinery etc. Efficient use of these energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness ofagriculture sustainability in rural living (Singh *et al*., 2002). Energy use in agriculture has beenincreasing in response to increasing population, limited supply of arable land, and a desire for higherstandards of living (Kizilaslan, 2009).

The increased use of inputs such as fertilizer, irrigation water, diesel, plant protection chemicals, electricity etc. demands more energy in the form of human, animal and machinery. The commercial energy used in agriculture increased nearly six fold with growth rate of 11.8% between1980-81 to 2000, but the share of agriculture in total energy consumption in the country increased 2.3 to 5.2% during the same period (Surendra Singh, 2002). About 57% of the Indian population depends upon agriculture.

The animate power contributed 92 percent of the total farm power in 1960-61 and mechanical and electrical together contributed only 8 percent. However the contribution of animate power came down to only 19 percent in 1999-2000(Singh. 2005).A study on energy consumption pattern in transplanted paddy cultivation. They reported that, irrigated farms consumed 57 to 201% more energy mainly through electricity, fertilizer, and diesel as compare to rain fed farms and resulted in to 20.4 to 67.3% higher crop productivity. Operational energy use was 40 to 50% of the total energy usage. Irrigation was the most energy consuming operation in irrigated farms followed by tillage, harvesting, threshing and transplanting.

Madhya Pradesh is the largest state having geographical area 31 million hectares along with the cropping intensity of 117.5% which is below national average 135% with the net sowing area of 19million hectare. Agriculture contributes 44% to the state economy. Multiple cropping schemes in Madhya Pradesh were possible through the extension of irrigation facility (32% in 2002), and introduction of farm equipment such as tractors, seed drills, multi crop threshers and combine (custom hiring). The tendency of farmers to utilize more energy to get higher productivity resulted in to higher farm power availability, which enhanced from 0.64 kW/ha in 1998 to 1.0 kW/ha in 2005.

The aims of this study were to determine direct input energy and indirect energy in Kamore plateau and Satpura Hill Region which belongs to wheat-rice zone of Madhya Pradesh, to investigate the efficiency of energy consumption.

2. Materials and Method

Data were collected from 120 farmers of different village of Kamore plateau and Satpura Hill Region of Madhya Pradesh by using a face to face questionnaire in December to April 2010-11. The simple random sampling method was used to determine survey volume (Kizilaslan, 2009).

$$N = \frac{N \times S^2 \times t^2}{(N-1)d^2 + S^2 \times t^2}$$

In the formula, the below signs and letters represent: n is the required sample size, s is the standard deviation, t is the t value at 95% confidence limit (1.96), N is the number of holding in target population and d is the acceptable error (permissible error 5%).Farmers were randomly selected and contacted with the help of Gram-Pradhan. After collecting preliminary information's related to their inventory, irrigation sources and type of farming system. It was tried that maximum farmers are contacted to have required information in present Performa. The farmers were classified as marginal, small, medium-sized and large farmers on the basis of their land holding as:

1. Marginal farmers (< 1.0 ha)
2. Small farmers (1.0-2.0 ha)
3. Medium farmers (2.0-4.0 ha)
4. Large farmers (> 4.0 ha)

The criteria were adopted in conformity with the usual practice as recommended by Mittal and Dhawan (1988).

Availability of power:

The inventory of hired (permanent and temporary) and family labour, draught animals (including all animals used for draught purpose carrying out agricultural operations), all power units including mobile (tractors) and stationary (diesel/gasoline engines and electric motors) were taken.

Crop yield:

The crop yield was also recorded by interviewing the farmers of the selected villages. Information like harvested crop and threshed crop in terms of weight was recorded in the pre-tested questionnaires.

Calculation of Energy

Energy from Direct Sources:

DE = HLH x 1.96 + BPH x10.10+ FC x 56.31 + EC x 11.93 …. (1)

Where,

DE = Direct Energy, (MJ)
HLH = Human labor hours used, (h/ha)
BP = Bullock pair hours used, (h/ha)
FC = Fuel consumption, (l/ha)
EC = Electricity consumption, (kWh/ha)

Source: Research digest on energy requirement in agriculture sector, CAE, PAU, Ludhiana (1985)

Energy from Indirect Sources:

IE = (C x WM x HUM x OA) + FYM X 0.3 MJ/kg + S x 14.7 MJ/kg + Ch. x 120 MJ/l x fertilizer (N X 60.0 X P X 11.1 X K x 6.7) ……………… (2)

Where IE = indirect energy input from machinery, (MJ)
C = energy coefficient, (MJ/Kg)
WM = Weight of machinery used per hour, (Kg)
HUM = hours use of machinery, (h)
OA = operational area (ha)
FYM = farm Yard Manure, (Kg/ha)
S = seed, (Kg/ha)

Source: Research digest on energy requirement in agriculture sector, CAE, PAU, Ludhiana (1985)

Total energy:

TE = DE + IE

Where,
DE = Direct Energy, MJ
IE = Indirect Energy, MJ

Based on theenergy equivalents(Pansar and bhatnagar, 1987) of the inputs and output output–input energy ratio, energy productivity, specific and energy net energy gain were calculated (Singh, 2002; Mohammadi *et al*., 2008; Sartori *et al*., 2005; Demircan *et al*., 2006.

$$\textbf{Output} - \textbf{Input ratio} = \frac{\textbf{Output energy}\left(\frac{\textbf{MJ}}{\textbf{ha}}\right)}{\textbf{Input energy}\left(\frac{\textbf{MJ}}{\textbf{ha}}\right)} \quad ..(3)$$

$$\text{Energy producty} = \frac{\text{Wheat output}\left(\frac{Kg}{ha}\right)}{\text{Inpu tEnergy}\left(\frac{MJ}{ha}\right)} \quad \ldots\ldots (4)$$

$$\text{Specific Energy} = \frac{\text{Inpu tEnergy}\left(\frac{MJ}{ha}\right)}{\text{Wheat output}\left(\frac{Kg}{ha}\right)} \quad \ldots (5)$$

Cropyield:

The crop yield was also recorded by interviewing the farmers of the selected villages. Information like harvested crop and threshed crop in terms of weight was recorded in the pretested questionnaires.

Computerization of data:

The primary data were computerized as per requirement of FORTRAN Programme available with energy requirement scheme. The data of wheat crop and inventory was subsequently pooled for further processing.

Processing of computerized data:

FORTRAN Program available with energy scheme was used for processing of data. The collected raw data were coded to in required format (MS DOS) and processed by using different programmes to being to in usable tabular form. These processed data in FORTRAN then translated to MS- EXCEL worksheet for further analysis work. The individual farmer-wise following information were used.

- Operation wise energy requirement (MJ/ha).
- Source wise energy use by farmers (MJ/ha).
- Crop yield (Kg/ha).
- Energy input through indirect sources.
- Energy input through direct sources.

3. RESULTS AND DISCUSSIONS

Operation wise energy use pattern:

Table 3.1 shows that the operation wise energy requirement during 2010-11 varied from 7737-10320 MJ/ha with mean value of 9318 MJ/ha,therewas significant difference in the energy utilization amongst all the category of farmers was observed in performing all the operations for wheat cultivation. Table 3.1 indicates that irrigation was the highest energy consuming operation and consumed (3670 MJ/ha) followed by seedbed preparation (2038MJ/ha), harvesting and threshing (1752 MJ/ha) and transportation (800MJ/ha) for wheat crop production in 2010-11.

Table 3.1.Operation wise energy use pattern (MJ/ha) for wheat crop.

Field operations	MF	SF	MSF	LF	Wt.avg.
Seedbed Preparation	1619	2243	2137	2156	2038
Sowing	992	1071	1054	1114	1058
Irrigation	3229	4003	3481	3968	3670
Harvesting	409	522	504	572	502
Threshing	1098	1119	1340	1442	1250
Transportation	390	796	979	1068	800
Total energy (MJ/ha)	7737	9754	9495	10320	9318

The effect of operation wise on wheat can be related by linear equation.Relationship between operation wise energy use and yield for wheat cultivation.

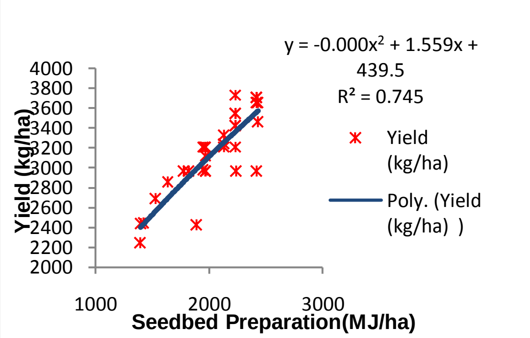

Fig.3.1 relation between seedbed preparation energy and yield of wheat crop.

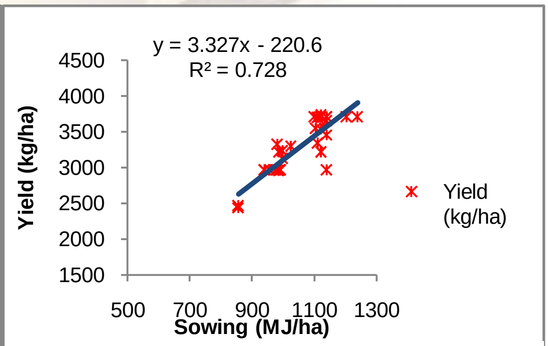

Fig.3.2 relation between sowing energy and yield of wheat crop.

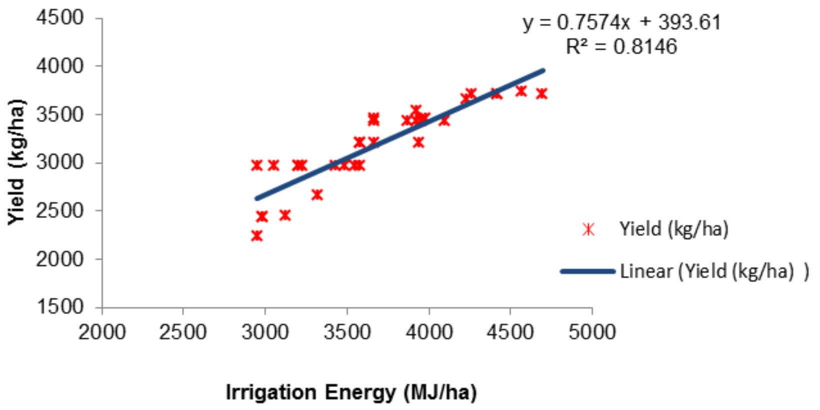

Fig.3.3 relation between irrigation energy and yield of wheat crop.

Source wise energy use pattern

Table 3.2 shows that the total energy input from different source was 14345 MJ/ha. The variation among the total energy input on the different categories of farmers was 13306 -15787 MJ/ha. Electricity and diesel contributed 24 percent and 20 percent of total energy in 2010-11. Electricity was used for irrigation and threshing whereas diesel was used mainly for tillage. The energy inflow through electricity was 3477 MJ/ha followed by diesel 2939 MJ/ha. Among the indirect source of energy the fertilizers supplied maximum (4468MJ/ha).

Table 3.2 Source wise energy use pattern (MJ/ha) for wheat crop production.

Source of energy	MF	SF	MSF	LF	Wt.Avg.
Human	684	692	718	678	693
Animal	25	15	0.	0	10
Diesel	2593	2631	2853	3682	2939
Electric	3158	3282	3501	3969	3477
Seeds	1997	2113	2287	2179	2144
Fertilizer	4232	4582	4424	4632	4468
Machinery	617	573	618	647	614
Total energy (MJ/ha)	13306	13888	14401	15787	14345

Table 3.3 Average energy use pattern and productivity.

Parameters (MJ/ha)	MF	SF	MSF	LF	Wt. Avg.
Direct energy	6441	6612	7072	8349	7118
Indirect energy	6846	7268	7332	7461	7227
Renewable energy	2687	2812	3005	2877	2845
Non- renewable energy	11737	11068	11399	2930	9283
Commercial energy	13734	13151	13686	5109	11420
Non- commercial energy	690	699	718	698	701
Productivity (kg/MJ)	0.26	0.28	0.28	0.28	0.27
Yield (kg/ha)	3105	3864	4086	4345	3850
Energy ratio	3.43	4.10	4.17	4.04	3.90

The effect of source wise on wheat can be related by linear equation.Relationship between source wise energy use and yield for wheat cultivation.

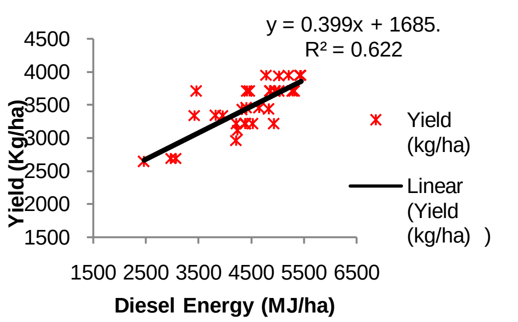

Fig.3.4 relation between diesel energy and yield

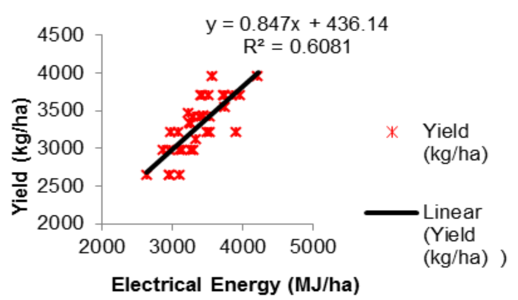

Fig.3.5 relation between electrical energy and yield of wheat crop.

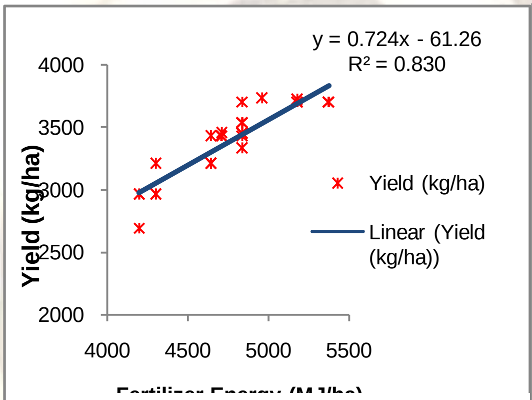

Fig.3.6 relation between fertilizer energy and yield of wheat crop.

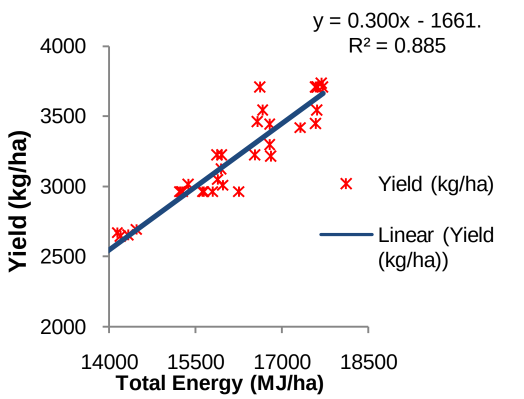

Fig.3.7 relation between total energy and yield of wheat crop.

s

CONCLUSION

In this study, energy consumption for input and output energies in wheat production was investigated in Kamore plateau and Satpura Hill Region of Madhya Pradesh. Data were collected from 120 farmers which were selected based on random sampling method. Total energy consumption in wheat production was 14345 MJ/ha of which chemical fertilizer, diesel fuel and electric energy consumption was 31.1%, 20.5% and 24.2%, respectively. Direct and Indirect energy were 49.6% and 50.4% respectively. Output Energy was 56595 MJ/ha. Output– input energy ratio and specific energy of production and productivity were 3.9, 3.7 MJ/kg and 0.27 kg/MJ, respectively. The use of commercial source is too high as compared to non-commercial energy sources. Commercial sources contributed about 97% per cent of total energy (14345 MJ/ha).Non-renewable energy was 82.1% total input energy that concluded that wheat production needs to improve the efficiency of energy consumption in production and to employ renewable energy. On the basis of linear programming the prediction of energy requirement for different levels of yield reveals that there exist a significant scope to enhance wheat productivity through increased use of input energy through fertilizer and machinery.

REFRENCES

[1]. Adhoo (1981) energy use pattern for different sizes farms and crops under varying lands of resource inputs in wardha district of Maharastra state.

[2]. Canakci, M., Topakci, I., Akinci, A., Ozmerzi, (2005), Energy use pattern of some field crops and vegetable production for Antalya Region, Turkey, Energy Conversion and Management (46): 655–666.

[3]. Dhawan, K.C. and Mittal, J.P. 1991.Role of fertilizers in increasing yield of various crops in India.Economic Affairs Calcutta.39 (2): 92-99.

[4]. Dipankar, De and Babu, Bhushana (2004), Energy consumption pattern in transplanted paddy cultivation in India, Journal of Agricultural Engineering, Vol.41 (4): 15-20.

[5]. Franzluebbers A.J. and C.A. Francis (1995) study on crop management systems to help farmers to maintain economic profitability.

[6]. Gurushami, T., G.R.K., Murthy, S.R., Desai, M., Mathew, and M., Veeranngoud, (1992). Energy use pattern for dry land crops in Madhya Pradesh, India, J. Agril. Engg. 2(3): 164-170.

[7]. Hatirlia, Ozkanb, SelimAdem, Burhan, Cemal, Fertb, (2005), An econometric analysis of energy input–output in Turkish agriculture, Renewable and Sustainable Energy Reviews (9): 608–623.

[8]. Joshi, N. L. (1989), efficient use of energy inputs in rainfed pearl millet, Agriculture, Ecosystems & Environment, Vol. 25 (2-3): 91-102.

[9]. Mohapatra, P.K; Senapathi, P.C. and Satpathy, D. 1991. Energy studies in cropping systems in lateritic soil of Orissa, India. A.M.A. 22 (1): 49-52.

[10]. Monlik T.K., DholakiaBakul H and Shulka PR (2008) Ref: Paper published by 111M Ahmadabad research & Publication department in its series 11MA working paper with number 867.

[11]. Pannu, C. J. S., Surendra, Singh, M. P, Singh, Sarjinder, Singh, and B. S., Bhangoo, (1993), Energy use pattern for a selected village in the cotton-belt of Punjab, Energy, Vol. 18 (11): 1113-1117.

[12]. Pathak, B.S. (1985). Energy demand growth in Punjab agriculture and changes in agricultural production. Energy in Agri. 4:67-78.

[13]. Shrivastava, N.S.L (2010) Ref: Farm Power Sources, their availability and future requirement to sustain agricultural production. Published in internet in the website.Agricoop.nic.in.

[14]. Singh H, Misha D, Nahar N.M and Ranjan M (2003) Energy use pattern in production agriculture of a typical village in arid zone, India: part II. *Energy Conversion and Management* 44: 1053-1067.

[15]. Singh, G. (2002). Energy conservation through efficient mechanized farming, Agricultural Engineering today's, Vol.24 (2).

[16]. Thakur, C. L., N. K, Khandelwal, and J. P. Mittal (1990). Energetics and economics of wheat production in two selected villages of Madhya Pradesh, India, held at the JawaharLal Nehru KrishiVishwaVidyalaya, Jabalpur, Volume 35, (11).

[17]. Vatsa D.K. (2006) Ref: Energy analysis for mechanizing Himachal Pradesh of India. Published in Agricultural Engineering today, Vol. 30.