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ENERGY INPUT FOR FODDER CROP PRODUCTIONS UNDER DIFFERENT TYPES OF FARMING SYSTEMS

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Abstract

The pattern of energy utilize in cultivation of fodder crop was studied under traditional and partially mechanized farming system. It was observed that the total operational energy was found to be 6883.83 MJ/ha and 7298.73 MJ/ha in traditional and partially mechanized farming system respectively. Out of which 48.52 and 56.21 percent was utilized by direct source of energy in different farming systems, whereas 51.48 and 43.79 percent was utilized by indirect sources of energy. The total energy cost in traditional farming system was Rs 86450 /ha. Similarly, the cost of energy in partially mechanized system was Rs 93201 /ha. This difference clearly indicates that traditional farming system can be replaced by partially mechanized farming system with more return.

Key word: Partially mechanized farming system Energy ratio, energy productivity etc.

Introduction

Energy is integral part to national development process and to provide major vital services that improve human requirements; fuel for cooking, light for living, motive power for transport, and electricity for modern communication. In agricultural sector, its use is in every form of inputs, seed, fertilizer, agro-chemical for plant protection, machinery use for various operation, housing, transport, and processing. Apart from solar energy, production agriculture uses basic additional energy inputs, soil, water, tractive power, chemicals for growth of plants. The amount of energy invested through these inputs and quantity actually used by the plant govern the crop growth and yield during their life cycle.

Singh *et al.* 202 has estimated that total energy input Indian agriculture increased by 3.6 times. In modern agriculture, commercial energy sources (fuel, machinery and chemicals) contribute bulk of the energy supplies to the production system. Commercial energy use in agriculture has been increasing since revolution with increasing use of diesel and electricity in farm operations. The share of agriculture in electricity consumption has increased from 3.9% of the total consumption in 1950-51 to 29.6% in 1993-94. Total commercial energy use in agriculture increased nearly fivefold with growth rate of 11.8% between 1980-81 to 1994-95. The share of agriculture in total consumption in the country increasing marginally from 3.2 to 5.2% during the same period. Increase in land productivity and efficient diversification of agriculture for better economic return to the producers will call for significantly higher level of input to agriculture (Mahapatra, 1991).

India is presently under heavy stress on account of a large-scale exploitation for fuel wood, timber and fodder, mismanagement of forest resources and frequent fires. There is acute shortage of fodder especially green nutritious fodder, which is major cause of low productivity of livestock, especially in hilly area (Deb Roy *et al.*, 1989). The main reasons for low productivity is insufficient and low quality fodder and feed including grazing facilities (Deb Roy, 1993). Therefore, India has been the home of major draught, milch and dual-purpose breeds of cattle. Indian dairy production system is complex and generally based on traditional and socioeconomic considerations. However, there has been a rapid change in way of agriculture (*i.e.* cropping system, water resources, diversification of crops, intensification of agriculture), increasing use of mechanical power, transformation from

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sustenance farming to market oriented farming, changing food habits etc., All these factors have their impact on animal husbandry practices. India has 15% of world cattle population and due to ever increasing population pressure of human, arable land is mainly used for food and cash crops, thus there is little chance of having good quality arable land available for fodder production, until milk production becomes remunerative to the farmers as compared to other field crops. In India, there is no practice of fodder production in rural areas and animals generally consume naturally grown grasses and shrubs which are of low quality in terms of protein and available energy, they are thus heavily dependent on seasonal variations and this results in fluctuation in fodder supply round the year affecting supply of milk round the year. The aim of the study is to investigate the energy input and output per unit area, energy output-input ratio, crop yield, specific energy, energy productivity, net energy for fodder crop production. Also make a cost and economic analysis for the crop production in study area for two groups of farmers with different level of technology and machinery ownership status.

Materials and methods

The study was conducted in Allahabad district (25.45°N and 81.84°E) in the state of Utter Pradesh (U.P.) located at northern part of India at an elevation of 98 meters and stands at the confluence of two rivers, the Ganga and Yamuna. Based on the criteria village Meja, Korawn, and Manda Block of district Allahabad were selected for the study. The soil analysis showed the structure of soil was clay and sandy loam (Anonymous 2010). The data were collected using a face-to-face questionnaire from two groups of 90 farmers growing fodder crop. The agricultural practices of the farmers based on the land holding, economic conditions and irrigation facility available. Based on the cultivation practices surveyed farmers were divided in two groups.

Group I (50 farmers) was using traditional farming system (Bullock operated). They were aware of the new development in the field of agriculture from various media like T.V., Radio, extension office, new paper etc. But those who are using traditional system of agriculture did not adopt partially mechanize system of farming due to financial constraints very small size of land holding and engagement in other jobs. Group II (40 farmers) was using partially mechanized farming system (Tractor operated) (Zangeneh *et al.* 2010).

The average size of the land holding was 0.5 and 2.3 ha for group I and II farmers respectively. The sample size was determined using a stratified random sampling technique (Yamane 1967).

$$n = \frac{\sum (N_h S_h)^2}{N^2 N^2 + \sum N_h S_h^2} \quad (1)$$

Where n is the required sample size; N is the number of total holdings in the target population; Nh is the number of the population in the h stratification; Sh is the standard deviation in the h stratification, S^2_h is the variance in the h stratification, D2 is equal to d2/z2; d is the precision, where $\bar{x} - \bar{X}$) (5%) is the permissible error and z is the reliability coefficient (1.96, which represents 95% reliability). The input requirement of fodder production were collected, determined and presented for every questionnaire as per the socio-economic structures of the farms.

Inputs in fodder production were machinery, human labour, chemical fertilizers, diesel, and seed. Output was fodder (grain) as a product. The energy equivalent of different input and output were used to estimate the energy values (Singh and Mittal 1992, Kitani 1999). The human energy input was calculated by multiplying the number of man-hours (h ha^{-1}) by estimated power rating of human labour (MJ h^{-1}) (Singh and Mittal 1992). Other inputs like diesel, seed, and chemical fertilizers used in fodder crop production were transformed to energy value (MJ ha^{-1}) by multiplying the quantity of the material used in the farms by the energy equivalent of each material. For example chemical fertilizer (nitrogen) energy consumption calculated by multiplying the amount of nitrogen usage (kg ha^{-1}) by energy coefficient of nitrogen fertilizer production (60.60 MJ kg^{-1}); so the result is the energy consumption of nitrogen fertilizer (MJ ha^{-1}) used in fodder crop production. Also, other energy inputs can be estimated hereby. Diesel pumps were used to lift the irrigation water, so irrigation energy was displayed as gasoline energy. The amount of output energy (MJ ha^{-1}) estimated by multiplying the fodder yield (kg ha^{-1}) by fodder crop energy equivalent (MJ kg^{-1}).

Output-Input Energy Ratio = Output energy (MJ ha^{-1})/ Input energy (MJ ha^{-1}) (2)

Specific Energy = Input Energy (MJ ha^{-1})/ Grain yield (Kg ha^{-1}) (3)

Energy Productivity = Grain yield (Kg ha^{-1})/ Input Energy (MJ ha^{-1}) (4)

Net Energy = Output Energy (MJ ha^{-1})/ Input Energy (MJ ha^{-1}) (5)

Human labour, machinery, diesel fuel, chemical fertilizers, farmyard manure, chemicals, water for irrigation, and output yield values of fodder crop have been used to estimate the energy output-input ratio, specific energy, energy productivity and net energy. Energy equivalents defined by the Singh and Mittal 1992, Kitani 1999 were used for estimation energy in this study. Direct energy constituted human labour and diesel fuel, whereas, indirect energy encompassed farmyard manure, complex chemical fertilizer, chemicals, machinery and water for irrigation.

In the last part of the study, the economic analysis of fodder crop was investigated. Net profit, gross profit and benefit to cost ratio were calculated. The gross value of production, net return and benefit to cost ratio were calculated using the following equations (Mohammadi *et al.*, 2008):

Total Production Value = Yield (kg ha^{-1})* cost ($ kg^{-1}) (6)

Gross return = Total production value ($ ha^{-1}) – Variable production cost ($ ha^{-1}) (7)

Net return = Total production value ($ ha^{-1}) – Total production cost ($ ha^{-1}) (8)

Benefit-cost ratio = Total production value ($ ha^{-1}) / Total production costs ($ ha^{-1}) (9)

Productivity = fodder yield (kg ha^{-1}) / Total production costs ($ ha^{-1}) (10)

Results and discussion

Operation wise inputs and output energy use in fodder crop production

Operation wise inputs used and output for fodder crop production in the surveyed area, and their energy equivalents with output energy rates and their equivalents are illustrated in Table 1. Total energy consumed in various farm operations during fodder crop production was 6883.83 and 7298.73 MJ ha^{-1} for group I and II respectively. Chemical fertilizer consumes maximum energy 37.69% for group I and 34.12% group II of total energy inputs during production period with second highest percentage difference. Energy consumed for irrigation of group I and II was 0.30% and 1.78 % respectively. The reason behind the difference in maximum percentage of irrigation was due to use of canal by group I, whereas also used electric motor & diesel pump for water lifting. Whereas group II was used diesel pump and electric motor only. Group I and II used 1379.44 and 1464.91 MJ ha^{-1} energy for sowing respectively. Harvesting was consumed 1771.37 MJ ha^{-1} energy for group I and 1599.32 MJ ha^{-1} energy for group II farms. Operation wise energy input ratio, percentage use energy and percentage difference for both group are shown in table 1.

Source wise energy input use in fodder crop production

Source wise input of energy input is shown in Table 2. Direct source wise energy calculated for Group I was 2997.31 MJ ha^{-1} (48.52%) and 4103.32 MJ ha^{-1} (56.21%) for Group II. Indirect source wise energy calculated for Group I and Group II were 3180.73 (51.48%) and 3197.02MJ ha^{-1} (43.79%) respectively. The input energy used as an indirect source was lowest for seed in both groups. Energy input ratio for group I and group II in direct energy was 1:1.4 and in indirect energy was 1:1 with respect to group I. Human energy use in both the group have 29.79% difference. Source wise energy requirement parameters, percentage use energy, ratio and percentage difference are given in Table 2.

Energy output-input ratio

The energy input and output, yield, energy use efficiency, specific energy, energy productivity and net energy offodder crop production in the study area were showed in table 3. Average yield at farmers field was recorded 50123and 62134 kg ha^{-1} and calculated total energy output was 902214 and 1118412 MJ ha^{-1} for Group I and II respectively. Energy use efficiency (energy ratio) was calculated as 131.06 and 153.23 for group I and II respectively. The average energy productivity of farms was 7.28 and 8.51 kg MJ^{-1}group I and II respectively. The specific energy offodder crop production were 0.14 and 0.12MJ kg^{-1} and net energy of fodder crop production were 895330.17 and 1111113 MJ ha^{-1} for Group I and II respectively. Energy ratio for both groups in input energy, output energy, output-input energy ratio, yield, specific

Table 1: Operation wise amounts of inputs and output in fodder crop production

Operations	Energy requirement				Ratio	%
Inputs (MJ ha^{-1})	Group I[a]	%	Group II[b]	%		Difference
Land preparation	1117.83	16.24	1614.21	22.12	1:1.4	5.88
Fertilizer application	2594.76	37.69	2490.24	34.12	1:1	3.57
Sowing	1379.44	20.04	1464.91	20.07	1:1.1	0.03
Irrigation	20.43	0.30	130.06	1.78	1:6.4	1.49
Harvesting	1771.37	25.73	1599.32	21.91	1:0.9	3.82
Total input energy	6883.83	100.00	7298.73	100.00	1:1.1	
Output						
Output (MJ ha^{-1})	902214		1118412		1:1.2	
Fodder crop (kg)	50123.00		62134.00		1:1.2	

[a] Farmers having bullock (Traditional farming system)
.[b] Farmers having tractor and low level of technology (Partially mechanized farming system)

Table 2: Source wise amounts of inputs and output in fodder crop production

Parameters	Energy requirement				Ratio	% Difference
	Group I	%	Group II	%		
Direct Energy (MJ ha^{-1})						
Human	1881.6	30.46	49	0.67	1:0	29.79
Bullock	1115.71	18.06	0	0.00		18.06
Diesel	0	0.00	4054.32	55.54		55.54
Total Direct energy	2997.31	48.52	4103.32	56.21	1:1.4	7.69
Indirect energy(MJ ha^{-1})						
Seed	367.5	5.95	294	4.03	1:0.8	1.92
Fertilizer/Chemical	2650.43	42.90	2456.75	33.65	1:0.9	9.25
Machinery	162.80	2.64	446.26	6.11	1:2.7	3.48
Total Indirect energy	3180.73	51.48	3197.02	43.79	1:1	7.69

Table 3: Energy output-input ratio in fodder crop production

Parameters	Unit	Group I	Group II	Ratio
Input energy	(MJ ha-1)	6883.83	7298.73	1:1.1
Output energy	(MJ ha-1)	902214	1118412	1:1.2
Output-input energy ratio		131.06	153.23	1:1.2
Yield	(kg ha-1)	50123.00	62134.00	1:1.2
Specific energy	(MJ kg-1)	0.14	0.12	1:0.9
Energy productivity	(kg MJ-1)	7.28	8.51	1:1.2
Net energy	(MJ ha-1)	895330.17	1111113	1:1.2

Table 4: Economic analysis of fodder crop productions

Cost and return components	Unit	Group I	Group II
Yield	kg ha^{-1}	50123.00	62134.00
Sale price	\$ kg^{-1}	0.1	0.1
Total production value	\$ ha^{-1}	5012.30	6213.40
Variable cost of production	\$ ha^{-1}	1127.77	1242.68
Fixed cost of production	\$ ha^{-1}	601.48	621.34
Total production cost	\$ ha^{-1}	1729.24	1864.02
Gross return	\$ ha^{-1}	3884.53	4970.72
Net return	\$ ha^{-1}	3283.06	4349.38
Benefit to cost ratio		2.90	3.33

*1$ = Rs 50

energy, energy productivity and net energy were 1:1.1, 1:1.2, 1:1.2, 1:1.2, 1:0.9, 1:1.2 and 1:1.2 respectively.

Economic analysis offodder crop production

The total cost of production, gross return, productivity and benefit to cost ratio of fodder crop are calculated using equation (6-10) and are shown in table 4 for both the group. The total production value for Group I was 5012.30 \$ ha^{-1} while in Group II was 6213.4 \$ ha^{-1}. Variable and fixed cost of production was 1127.77, 1242.68 \$ ha^{-1} and 601.48, 621.34 \$ ha^{-1} for group I and group II, respectively. Total production cost in fodder crop for group I was 1729.24 \$ ha^{-1} and 1864.02 \$ ha^{-1} for group II. Gross return in group I was 3884.53 \$ ha^{-1} whereas in group II 4970.72 \$ ha^{-1}. The net return in group II was 3283.06 \$ ha^{-1}, higher than group I 4349.38 \$ ha^{-1}.

Conclusion

The total operational energy under traditional farming system (Group I) and partially mechanized farming system (Group II) were also evaluated which was more on case of Group II as compared to Group I. Source wise energy was also having the similar rise in case of Group II. Energy consumption was highest in fertilizer application in both the group which was 37.69% and 34.12% for Group I and II respectively. Output-input energy ratio under traditional and partially mechanized faming systems was 131.06 and 153.23. The operational specific energy in traditional and partially mechanized system was 0.14 and 0.12 MJ kg^{-1}. Energy productivity (kg MJ^{-1}) for Group I is 7.28 and 8.51 for Group II. The yield in Group II system is more than Group I system because of more use of energy. Specific energy, output-input energy ratio and energy productivity of group I and group II were also calculated and discussed. In an economic analysis of group I and II the benefit to cost ratio was 2.90 and 3.33 respectively. The net return of group II was found more than group I. This study shows that economically, partially mechanized farming system is more profitable than traditional farming system. So, traditional farming system should be changed with the partially mechanized farming system in fodder crop production.

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