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Economic Evaluation and Energy Use of Turnip Rape (Brassica Compestris L cv. KOS-1) in Intermediate Zone of Jammu and Kashmir

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Abstract- A field experiment was conducted in Rabi seasons of* 2013-2014 and 2014-2015, *to find out the consumption of input energy (MJ) and output energy (MJ) used in* Turnip rape (*Brassica compestris* L *cv. KOS-1*) *production in intermediate zone of Jammu and Kashmir. Energy being the critical aspect of agricultural production, modern agricultural system takes into account all the agricultural operations in terms of energy input and the yield obtained as energy output. It is this energy balance equation which describes the viability of a system. Depending upon the variation in energy consumption among various agro-climatic and environmental conditions and the output therein, a wide variation exists in the viability of these systems. In the present study, the energy balance in Turnip rape management system was taken into consideration. The total energy consumed for production of Turnip rape crop was 9915.2 MJ/ha of which fertilizer application was 70.09% followed by fuel 17.89%. The output – input energy ratio and the energy productivity were found to be 2.017 MJ respectively using existing energy input in intermediate zone of Jammu and Kashmir.

Key words: Turnip rape, Energy management, Energy sources, Relative economics

I. INTRODUCTION

Agriculture is a vital sector in the Indian economy. Indian agriculture provides employment to 70% of the population generates 40% of the national income and consumes about 10% of the commercial forms of energy. Energy use in agricultural production has become more intensive due to use of fossil fuel, chemical fertilizers, pesticides, machinery, and electricity to provide substantial increases in food production. Efficient use of energy is one of the principle requirements of sustainable agriculture. Many researchers have studied energy and economic analysis to determine the energy efficiency of plant production such as sugarcane in morocco (Mrini *et. al*., 2001), Apple in Iran (Rafiee et al 2010), Cucumber in Iran (Mohammadi and Omid , 2010). Similarly Turnip rape (*Brassica compestris L var. Brown sarson*) requires application of animate /inanimate (bullock, man power/ tractors, tillers, etc) forms of energy at different stages.

For checking any disease, insect–pest, weeds, etc, chemicals and manpower and ultimately energy is required to fulfill all the operations necessary for crop growth and yield. Efficient use of energy in agriculture will minimize environmental problems, prevent destruction of natural resources, and promote sustainable agriculture as an economical production system (Dalgaard et al. 2001). Agriculture uses energy directly as fuel or electricity to operate machinery and equipment, to heat or cool buildings, and for lighting on the farm, and indirectly in the fertilizers and chemicals produced off the farm (Alam et al. 2005; Ozkan et al. 2004).

To meet the basic food needs of our expanding human population, a productive sustainable agriculture must become a major priority; generally in order to obtain higher productivity, farmers in general use their resources in excess and inefficiently particularly when these are priced low or free or are available in plenty. So the present study deals with input– output energy use in Turnip rape with the aim to determine the total amount of energy utilized and make decisions with regard to energy management of Turnip rape production under intermediate zone of Jammu and Kashmir.

II. MATERIALS AND METHODS

A field experiment was conducted with Turnip rape (*Brassica compestris L*) cultivar 'KOS-1' at Research farm Rajouri, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during *Rabi* 2013-2014 and 2014-2015 in randomized block design with three replications. The soil of the experimental field was clay loam in texture with pH 7.2, EC 0.10 ds/m, organic carbon 0.68%, alkaline permanganate oxidizable available nitrogen 430 kg/ha, Olsen's available phosphorus 18.4 kg/ha and available potassium 246 kg/ha. Crop was sown using seed rate of 7.5 kg/ha and row spacing of 30 cm on 15th Oct in 2013 and 30th Oct in 2014 respectively. Plant spacing of 10 cm within row was maintained by thinning the crop after winter. Fertilizers were applied as per the farmers practice. Energy evaluation was worked out by taking all the farm operations in consideration, same as carried out by the farmers in their fields. Data were collected from the growers by using a face-to-face questionnaire. The sample size was calculated using the Neyman method (Yamane 1967) with the farms classified into three groups as small (<= 0.6 ha), medium (0.6 <= 1.5 ha) and large (> 1.5 ha). The output data with respect to the yield was averaged out by collecting information from the farmers. As such all the farm operations were converted into energy (MJ) given by using energy equivalents by Devasenapathy *et. al*., 2009, also the output was converted into energy (MJ). The energy use efficiency (energy ratio) and energy productivity were calculated using the following formulae (Mohammadi *et al*. 2008):

Energy ratio = Energy output (MJ/ha)/Energy input (MJ/ha)

Energy productivity = Turnip rape output (kg/ha)/Energy input (MJ/ha)

III. RESULTS AND DISCUSSION

Energy source

The energy source can be classified in a number of ways based on the nature of their transaction, also the energy sources are classified based on animate and inanimate characteristics.

Classification of energy

On the basis of source, the energy can be classified as direct and indirect energy.

Direct source of energy

The direct source of energy are those forms that release the energy directly – like man power, bullocks, stationary and mobile mechanical or electric power units viz. diesel engines, electric motor, power tiller and tractors. The direct energy may be further classified as renewable and non renewable sources of energy depending upon their replenishment. Renewable direct sources of energy include the energy sources which are direct in natural but can be subsequently replenished. The energies which may fall in this group are human beings, animals, solar and wind energy, fuel wood, agricultural wastes, etc.

Non renewable direct sources of energy are the direct energy sources which are not renewable at least in near further say next 100 years are classified as Coal and fossil fuels.

Indirect source of energy

The indirect sources of energy are those which do not release energy directly but release it by conversion process. Some energy is invested in producing indirect sources of energy. Seed, manures, FYM, chemicals, fertilizers and machinery can be classified as indirect sources of energy.

All the crops require energy either direct or indirect. In case of Turnip rape, different forms of energy are required either in direct or indirect form (Table1). Which are converted to calculate the total energy consumed in Turnip rape crop (Table 2).

Table 1. Equivalents for various sources of energy in Turnip rape crop during 2013-14 and 2014- 15.

Particulars	**Unit**	**(MJ) Eq. energy**		**Remarks**
		2013-2014	**2014-2015**	
Inputs				
Human labor				
(a) Adult man	Man hour	1.96	1.98	
(b) Woman	Woman hour	1.57	1.57	1 Adult woman = 6.8 adult man
(c) Child	Child hour	0.98	0.96	1 Child = 0.5 adult man.
Animals				
(a). Bullocks				
(i) Large	Pair hour	14.05	14.10	Body weight above 450 kg
(ii) Medium	//	10.10	10.12	// 352 – 450 kg
(iii) Small	//	8.07	8.09	// < 350 kg
Diesel	Litre	56.31	57.20	Including cost of lubricant
Chemical fertilizers				
(i) N				
(ii) P_2O_5	kg	60.60	60.60	
(iii) K_2O	kg	11.1	11.1	
	kg	6.7	6.7	
FYM	Kg (dry mass)	0.3	0.3	
Seed	Kg (dry mass)	25.0	25.0	

Table 2. Average amounts of inputs and outputs in Turnip rape during 2013-14 and 2014-15

S.NO		**Operations/Inputs**	**No./Qty**	**Rate (Rs).**	**Av. (two yrs) of cost/ha with Tractorization (Rs)**	**Av. (two yrs) of Farmers way with bullocks (Rs)**
A		Power cost				
	1	Tractorization	3 tilling	200/Kanal	4000	
`	2	Tillage with bullocks	20 pairs			4000

		Total			4000	4000
B		Material cost				
	1	Cost of seed	7.5 kg	23/kg	173	173
	2	Cost of fertilizer				
		N= 60 Kg/ha	Urea =106 kg/ha	544/q	576	576
		$P_2 O_5$ = 30 Kg/ha	DAP=66 kg/ha	1044/q	689	689
	3	Cost of plant protection			500	500
		Total			2046	2046
C		Labour cost				
	1	Fertilizer application	2 labours	120	240	240
	2	Sowing of seeds by line method				
		Opening of furrows	30 labours	120	3600	3600
		Placing of seeds & covering of furrows	14 labours	120	1680	1680
	3	Sowing of seeds by broadcast	2 labours	120	240	240
	4	Weeding , hoeing and thinning	20 labours	120	2400	2400
	5	Harvesting & toeing	12 labours	120	1440	1440
	6	Threshing, cleaning etc.	10 labours	120	1200	1200
		Total			10800	10800
		Grand Total			13246	13246
		Returns				
		Seed yield	12.28q/ha			
		Cost of seed/qt	Rs. 2400			
		Cross returns	Rs. 29472			
		Net returns			Rs.16226	Rs.16226

Among the various forms of energy used as input during the production of Turnip rape were manual power utilized for various operations was 88 man heads which was equal to 290 hours amounting to energy of 1034.88 MJ, mechanized power which when converted in terms of energy amounting to 161.88 MJ, fossil fuel input in terms of energy was 1773.8 MJ, fertilizers utilized when converted in terms of energy were found to be 6950.52 MJ which were 70.09% of the total energy input. (Table 3)

Table 3. Average of energy calculation in Turnip rape during 2013-14 and 2014-15

Particulars	**Energy source**	**Quantity**	**(MJ) total energy**
Field preparation 1.Tractorization Tractor ploughing with cultivator 3/ha for 2 ploughings	Mechanical	6 hrs	80.99 MJ
2. Pulverizing the soil with rotavator 3hrs.		3 hrs	40.49
3. Diesel for ploughing	21 lit.	6 hrs	1182.5
4. Diesel for rotavator	10.5 lit.	3 hrs	591.3
5. Man power		3 l	1764
6. Formation of ridges & furrows and sowing	44 labours	4 hrs 264 hrs @ 1.96/h	40.4 517.44
B. Fertilizer application N $P_2 O_5$ $K_2 O$ Labour	100 kg 60 kg 30 kg 2 labour	@ 60.60 @ 11.1 @ 6.7 12 hours	6060 666 201 23.52
C. weeding /hoeing /thining	20 labours	120 hours	235.2
D. Harvesting & tieing	12 labours	72 hrs	141.12
C. Threshing cleaning etc	10 labours	60 hrs	117.6
Total	**Energy**	**-**	**9915.2 (MJ)**

As far as the average yield of Turnip rape is concerned, approximately 8 q/ha is obtained under field conditions, as per kg seed (dry mass) gives 25 MJ, thus for 1 ha 25 x 800 MJ = 20,000 MJ which is almost double the energy utilized in producing the yield. Similar energy management has been worked out on cotton crop by Devasenapathy *et. al.* (2009). This indicates a high energy use efficiency which can even be increased by minimizing the energy utilized to have a larger difference in consuming and getting energy.

The energy indexes of the medium farms were higher than those of the small and large farms. On another hand, the use of optimum energy implied that the farmers in all levels of production used higher energy than the optimum. The inefficient use of chemical fertilizers and diesel fuel inputs for oil seed production leads to problems beyond the scope of agricultural production, increasing production costs and negative effects to environment, human health, and sustainability. Farmers must be provided with educational opportunities in the use of efficient inputs, and this is the responsibility of policy makers in the area.

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