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Energy use in production of cotton in Bikaner district of Rajasthan

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ABSTRACT : The analysis of energy requirement revealed that maximum use of energy was in irrigation, seedbed preparation and picking in cotton. The operational energy was found highest on large farms followed by medium and small farms. The source wise energy analysis revealed that fertilizer, diesel, human labour and chemicals were main energy inputs, which affected the cotton production. The maximum use of renewable energy was on small farms while non renewable energy use was maximum on large farms. In cotton, the energy ratio was 3.1 suggesting that cotton crop was highly remunerative crop. The analysis of functional relationship between cotton yield and energy inputs revealed that machinery and irrigation energy contributed significantly to the cotton yield.

Key words: Direct energy, energy, indirect energy, non renewable energy, renewable energy

Agriculture uses large quantities of locally available non commercial energies, such as seed, manure and animate energy, and commercial energies directly and indirectly in the form of diesel, electricity, fertilizer, plant protection chemicals, irrigation water, machinery etc. Efficient use of these energies helps to achieve increased production and productivity and contributes to profitability and competitiveness of agricultural sustainability of rural living. In the agricultural sector, the energy use pattern for unit production and processing of crops has been observed to vary under different agro climatic zones.

A detailed energy census and resource availability surveys have been conducted by Vyas and Singh (1984) for the village Hambran, district Ludhiana, Punjab State (northern India), by Maheshwari *et al.,* (1981) for the village Islamnagar, district Bhopal, Madhya Pradesh State (central India) and by Swaminathan and Ramanathan[3] for the village Selkkachal, district Coimbatore, Tamil Nadu State (southern India). Attempts have also been made to collect information on one aspect or the other for a number of villages at different locations in India under All India Coordinated Research Project on Energy Requirement in Agricultural Sector. The present study is an attempt to document energy use pattern and the availability of resources in the ecosystem of Indira Gandhi Canal Command (IGNP) area of Bikaner for planning to meet the energy demand through use of alternate energy and scarce available resources in the region.

Multi stage sampling was used for the selection of farmers. Bikaner district was purposively selected because it has Rajasthan canal command area (IGNP) where cotton is grown. The study was conducted in 17 KYD village from Loonkaransar tehsil where cotton was grown. For the selection of respondents, a complete enumeration of all the farmers in the selected village was made. Forty farmers from different categories *viz.,* small, medium and large, were selected with probability proportional to number of farmers in each size group. An appropriate schedule was prepared for the purpose of data collection. It covered different agricultural operations done in cultivation of cotton. Data pertained to the agricultural year 2010-2011. The primary data were compiled and tabulated. A tabular analysis of data were undertaken to arrive at the final results. Percentages and averages were used for the interpretation of the results. Multiple linear regression was fitted to estimate the impact of various energy inputs on cotton yield.

Power Sources in cultivation of cotton: Data in presented in Table1 showed use of power sources in cultivation of cotton. Seedbed preparation of cotton required 28.5, 3.5 and 0.6 h/ha of a camel on small, medium and large farms, respectively. Less use of animal power on large farms was due to the fact that tillage operations were done by tractor drawn cultivator. The use of tractor drawn cultivator on large farms was high (4.2 h/ha) as compared to small (0.5 h/ha) and medium farms (3.9 h/ha). Maximum number of man-h/ha (30.5 h/ha) for seed bed preparation was used on small farms and lowest on large farms (5.2 h/ha).

The use of man h/ha for sowing (5.8-8.1 h/ha) decreased with increase in the size of land holding. Use of man h/ha was higher (8.1 h/ha) on small farms mainly because animal power was used for sowing on these farms. The large farms used more tractor h/ha (2.5 h/ha) for sowing, therefore, number of man h/ha required for sowing was less on these farms. Bund making was mostly done manually. The use of man h/ha and tractor h/ha for bund making was more or less the same on all type of farms.

Table 1. Use of power sources for cotton in selected village under irrigated conditions

Operation	17 KYD			
	Small	Medium	Large	**Average**
Seed bed preparation				
Man (h/ha)	30.5	8.2	5.2	**14.6**
Animal (h/ha)	28.5	3.5	0.6	**10.9**
Tractor (h/ha)	0.5	3.9	4.2	**2.9**
Diesel (l/ha)	2.0	12.6	19.6	**11.4**
Sowing				
Man (h/ha)	8.1	7.5	5.8	**7.1**
Animal (h/ha)	8.5	1.6	0.7	**3.6**
Tractor (h/ha)	0.9	1.9	2.5	**1.8**
Diesel (l/ha)	3.6	8.1	10.5	**7.4**
Bund making				
Man (h/ha)	2.6	0.1	2.6	**1.8**
Tractor (h/ha)	1.8	1.9	2.1	**1.9**
Diesel (l/ha)	2.0	2.3	2.5	**2.3**
Irrigation				
Man (h/ha)	48.5	42.6	43.6	**44.9**
Engine (h/ha)	12.2	14.6	15.7	**14.2**
Diesel (l/ha))	12.5	14.3	15.9	**14.2**
Canal (h/ha)	5.6	5.7	5.5	**5.6**
Weeding				
Man (h/ha)	280.6	265	242.3	**262.6**
Fertilizer application				
Man (h/ha)	2.2	3.5	3.6	**3.1**
Spraying				
Man (h/ha)	130.5	118.6	108.1	**119.1**
Picking				
Man (h/ha)	261	275	303	**279.7**
Tractor (h/ha)	0	0	0	**0.0**
Diesel ((l/ha))	0	0	0	**0.0**
Transportation				
Man (h/ha)	1.5	6.8	4.5	**4.3**
Animal (h/ha)	2.3	0.5	0.2	**1.0**
Tractor (h/ha)	0	1.0	1.5	**0.8**
Diesel ((l/ha))	0	3.0	4.0	**2.3**

Use of diesel engine for irrigation was maximum on large farms (15.7 h/ha) and lowest on small farms (12.2 h/ha). On an overall basis, the maximum manpower in irrigation was used on small farms (48.5 h/ha) and lowest on large farms (43.6 h/ha). In cotton, weeding was done manually. The man h/ha in weeding decreased with increase in size of holding. The use of man power in fertilizer application and spraying had a tendency to increase with increase in the size of land holding. On an overall basis, the weeding required 280.6 man h/ha on small farms followed by 265 man h/ha on medium and 242.3 man h/ha on large size farms. Fertilizer application required 2.2, 3.6 man h/ha. On an overall basis, the maximum use of man power in spraying was on small farms (130.5 h/ha) and minimum on large farms (108.1 h/ha). This is due to the fact that large farms used power sprayers for spraying in cotton crop for control of disease and insect pest.

Picking of cotton was done manually and required 261, 303 h/ha of man power on an overall basis. For picking, use of man h/ha was highest on large farms (303 h/ha) and lowest on small farms (261 h/ha).

Energy use pattern: Operation wise energy use for cotton is given in Table 2. It revealed that total energy use was maximum on large farms (7477 MJ/ha) followed on medium farms (6726 MJ/ha) and small farms (5446 MJ/ha). The total energy consumed in different farm operations increased with the increase in the size of land holding. Maximum energy was used in irrigation followed by seedbed preparation, sowing, picking, weeding, bund making, spraying

and transportation. Maximum energy in irrigation was used on large farms (3373 MJ/ha) followed by medium farms (3263 MJ/a) and small farms (2997 MJ/ha). The maximum use of energy in seedbed preparation was on large farms (1407 MJ/ha) followed by medium farms (1028 MJ/ha) and lowest on small farms (494 MJ/ha). The use of energy in bund making increased with the increase in the size of land holding. Similarly, in sowing, the maximum energy was used on large farms (781 MJ/ha) followed by medium (617 MJ/ha) and small farms (366 MJ/ha). The maximum energy for picking was used on large farms (594 MJ/ha) followed on medium farms (539 MJ/ha) and small farms (512 MJ/ha). Transportation by tractor drawn trolley required more energy on large farms since more diesel was spent in transporting the produce. The use of energy in weeding and spraying application decreased with the increase in the size of land holding while reverse trend was observed in fertilization, where it increased with increase in the size of land holding.

Table 2. Operation wise energy use (MJ/ha) for cotton in selected village of Bikaner district

Operation	17 KYD			
	Small	Medium	Large	**Average**
Seed bed preparation	494	1028	1407	**976**
Sowing	366	617	781	**588**
Bund making	240	264	290	**265**
Irrigation	2997	3263	3373	**3211**
Weeding	550	519	475	**515**
Fertilizer application	4	7	7	**6**
Spraying	256	232	212	**233**
Picking	512	539	594	**548**
Transportation	26	256	339	**207**
Total	**5446**	**6726**	**7477**	**6550**

Source wise energy: Data presented in Table 3 give source wise energy use for cotton crop. Total energy input needed for cultivation of cotton crop was maximum on large farms (12462 MJ/ha) and minimum on small farms (10117 MJ/ha). The indirect energy input increased with the increase in the size of land holding. Direct energy use through man power source was highest on small farms (1500 MJ/ha) and lowest on large farms (1409 MJ/ha). Energy used through animal source was highest on small farms (397 MJ/ha) and lowest on large farms (15 MJ/ha). The use of energy through diesel was highest on large farms (2956 MJ/ha) followed by medium (2269 MJ/ha) and small farms (1132 MJ/ha). The indirect energy used through seeds was highest on small farms (450 MJ/ha) and lowest on large farms (375 MJ/ha). Similarly, the fertilizer energy was highest in large farms (6805 MJ/ha) followed by medium (6670 MJ/ha) and small farms (6123 MJ/ha). The energy used through machinery was highest on large farms (458 MJ/ha) and lowest on small farms (96 MJ/ha). The seed energy input decreased with the increase in the size of land holding while reverse trend was found in fertilizers, chemicals and machinery, where it increased with increase in the size of land holding.

Yield and energy ratio of cotton: The average yield of cotton varied between 1700 to 2300 kg/ha on an overall basis (Table 4). It was highest on large farms (2300 kg/ha) and lowest on small farms (1700 kg/ha). The energy ratio which reflects output energy/unit of input energy varied between 3.0 3.3. It was highest on large farms (3.3) and lowest on small farms (3.0). This revealed that output energy obtained/unit of input energy wise was highest on large farms. Cultivation of cotton required 1799 2347 MJ/ha energy from renewable sources and 7770 10663

Table 3. Source-wise energy use (MJ/ha) for cotton in selected village

Operation	17 KYD			
	Small	Medium	Large	**Average**
Direct energy				
Human	1500	1430	1409	**1446**
Animal	397	57	15	**156**
Diesel	1132	2269	2956	**2119**
Sub total	3029	3756	4380	**3722**
Indirect energy				
Seeds	450	425	375	**417**
Fertilizers	6123	6670	6805	**6532**
Chemicals	420	432	444	**432**
Machinery	96	397	458	**317**
Sub total	7089	7924	8082	**7698**
Total input energy	**10117**	**11680**	**12462**	**11420**

Appendix- 1. Energy equivalents of inputs and outputs

Particulars	Units	Equivalent energy, MJ	Remarks
1. Human Labour			
Adult man	Man/h	1.96	1 adult women =
Women	Women/h	1.57	0.8 adult man
Child	Child/h	0.98	1 child =
			0.5 Adult man
2. Animals			
Bullocks	Pair/h	14.05	
Large	Pair/h	10.10	
Medium	Pair/h	8.07	
He buffalo	Pair/h	15.15	
Camel or horse	Animal/h	10.10	
3. Diesel	L	56.31	
4. Petrol	L	48.23	
5. Electricity	KWh	11.93	
6. Kerosene	L	43.00	
7. Machinery			
Electric motor	H	64.80	
Prime movers other than eclectric motors	H	68.40	
Farm machinery excluding self propelled machines	H	62.70	
8. Chemical fertilizers			
Nitrogen	kg	60.60	
Phosphorus	kg	11.10	
Potassium	kg	6.70	
9. Chemicals			
Insecticide/pesticide	kg/l	120.00	
Zinc sulphate	kg	20.9	
10. Outputs			
I. Main product			
Cereal crop (wheat, barley)	kg (dry mass)	14.7	
Pulse crops (mothbean, moonbean, gram)	kg (dry mass)	14.7	
Oilseeds crops (Groundnut and mustard)	kg	25.0	
Fodder crops (Guar and Bajra)	kg	18.0	
Fibre crops (Cotton)	kg	18.0	
II. By products			
Straw, vines etc	kg	12.5	
Stalks, cobs, fuel wood	kg	18.0	
Dung	kg	18.0	
Fire woods	kg	18.0	
Agriculture waste	kg	18.0	

*MJ is Mega Joules

Appendix-2. Energy sources grouped under different categories of energy

Category of energy	Source of energy
Direct energy	Human, animal, diesel and electricity
Indirect energy	Seeds, Chemicals, fertilizers and machinery
Renewable energy	Human, animal, seeds and manures etc.
Non-renewable energy	Diesel, chemicals, fertilizers and machinery

Table 4. Yield and energy ratio for cotton in selected village

Operation	17 KYD			
	Small	Medium	Large	**Average**
Yield (Main product), (kg/ha)	1700	2000	2300	**2000**
Total input energy (Main product), (GJ/ha)	10.1	11.7	12.5	**11.4**
Output energy (Main product), (GJ/ha)	30.6	36.0	41.4	**36.0**
Energy ratio (Main product)	3.0	3.1	3.3	**3.1**
Renewable energy, (MJ/ha)	2347	1912	1799	**2019**
Non-renewable energy, (MJ/ha)	7770	9768	10663	**9400**

MJ/ha energy from non renewable source. The use of renewable energy had a tendency to decrease with increase in the size of land holding, whereas use of non renewable energy had a tendency to increase with increase in size of the holding.

Energy inputs and crop yield relationship: Functional relationship between different energy inputs and yield of cotton is given in Table 5. The empirical results indicated that machinery and irrigation energy were found statistically significant and contributed to yield of cotton indicating further scope of increasing output energy by increasing use of these energy inputs. The spray energy was not significant indicating its excess use in cotton in the study area.

Table 5. Functional relationship between yield (kg/ha) and different energy inputs of cotton under irrigated conditions.

Cotton crop	Constant	Regression coefficient (b_i)	S.E.	t-value	R^2
	-12100.6				
Seed energy (x_1)		-1.627	1.140	-1.427	0.98
Nitrogen energy (x_2)		-0.579	0.793	-0.730	
Phosphorus energy (x_3)		0.245	1.633	0.150	
Human energy (x_4)		0.992	1.530	0.648	
Animal energy (x_5)		0.0016	0.037	0.430	
Machinery energy (x_6)		3.226*	1.337	2.413	
Irrigation energy (x_7)		5.524**	0.938	5.891	
Spray energy (x_8)		-0.788	2.112	-0.373	

* And** significant at 1% and 5% level of significance, respectively

REFERENCES

Anonymous, 1983. *"Biennial Report (1981-1983)"*, Energy requirement in agricultural sector, Department of Farm Power and Machinery, PAU, Ludhiana.

Maheshwari, R.C., Srivastava, P.K., Bohra, C.P., Tomar, S.S. and Nema, B.P. 1981. Energy census and resource assessment of village Islamnagar, district Bhopal, CIAE, Tech. Bullletin No. 81128. Bhopal, p. 1 99.

Mittal, l.P., Dhawan, K.C. 1988. *Research manual on energy requirements in agricultural sector,* Coordinationg cell, All India, Coordinated Research Project on Energy Requirements in Agricultural Sector. Punjab Agricultural Univ., Ludhiana.

Swaminathan, K.R. and Ramanathan, R. 1984. Energy census and resource assessment of village Selkkachal. district . Coimbatore, Tamil Nadu, Agri. Univ., Coimbatore.

Vyas, S.K. and Singh, N. 1984. Energy census and resource assessment of village Hambran, district Ludhiana, PAU, Ludhiana.

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