Madras Agric. J. 89 (1-3) : 1-4 January-March 2002

https://doi.org/10.29321/MAJ.10.A00168

Energy consumption scenario for Kar paddy in high rainfall zone of Tamil Nadu

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Abstract: In the high rainfall zone of Tamil Nadu, an energy audit was conducted to assess the impact of energy consumption pattern in paddy cultivation due to improved package of practices and mechanization. The study was carried out in two crop years namely 1989-90 and 1997-98 for Kar season. The study was conducted from one hundred randomly selected paddy growing farmers in the zone. It was found out from the analyzed data, that the total energy utilized has increased from 15,801 MJ ha^{-1} in 1989-90 to 18,964 MJ ha^{-1} in 1997-98 and the productivity has increased from 3,060 kg ha^{-1} in 1989-90 to 4,442 kg ha^{-1} in 1997-98. Quadratic model was fitted to understand the spatial variation in total energy consumption and yield. It was found out that the productivity level was proportionately reducing beyond certain level of energy utilization.
(Key words: Kar, Paddy, Energy).

Paddy is the staple food of our people and there is always a growing demand for paddy in our country due to ever increasing population. Paddy is mainly grown in Cauvery Delta Zone, Chengalput, Villupurarn, Tirunelveli and Kanniyakumari (high rainfall zone) areas. Since, everybody born in our country has the right for food and shelter, it is going to be very difficult for farming communities, scientists involved and policy makers to feed the population forever, because of grain cost and energy involved in the changing global market scenario. Hence, it is important to assess the impact of modernization or technological improvements in farming in terms of costs involved, energy consumed, product demand and supply. The cost incurred is otherwise related to energy utilized. In this context, a study was conducted to ascertain the impact of energy usage pattern in Kar paddy production in high rainfall zone of Tamil Nadu during 1989-90 and 1997-98.

In high rainfall zone of Tamil Nadu, paddy was cultivated in all the seasons covering an area of 43,905 ha during 1989-90 and 31,244 ha during 1997-98 (Anonymous, 1989 and 1997). Rice production has registered a reduction in quantity from 1,44,964 tonnes in 1989-90 to 1,27,803 tonnes in 1997-98. The average yield registered was 3364 kg ha^{-1} in 1989-90 (Anonymous, 1989) while it was higher by 13 per cent in 1997-98 (Anonymous, 1997). The increased production was mainly attributed to the technological improvements in the paddy cultivation, better irrigation facilities and machineries use. These advanced practices were followed to increase the productivity without considering the energy use impact and its after effects.

Materials and Methods

In the high rainfall zone, one hundred paddy growing farmers in Kar season (May to August) were randomly selected and energy audit was conducted covering all physical inputs, human, animal and machine hours, irrigation type, machinery use, tools used and electricity consumed. The audit was carried out in two different crop years namely 1989-90 and 1997-98 for the same set of farmers using a pre-tested questionnaire supplied by ICAR - AICRP - ERAS coordination cell. Selection of farmers was carried ut by considering the factors namely nearness : asy accessibility, typically rural in nature being influenced by urbanity. The farm selected from all the taluks fulfilling tl criteria. All the farm categories such as s.. small, semi-medium, medium and large ha considered while carrying out the ener The data were collected on the bas back survey and analyzed for sou operation-wise energy consumption pa computer with a FORTRAN based softw. input data were converted into energy te the energy equivalents given by Mi 1985. The output obtained after tabulated in terms of source-wise . iat aried

Table 1. Source-wise energy consumption pattern for kar paddy cultivation

Sources	1989-90		Percent to the 1989-90 Average	1997-98		Percent to the 1989-90 Average
	Average MJ/ha	Total GJ		Average MJ/ha	Total GJ	
Human, e_1	2,602	49,238	16.47	2,220	32,206	14.05
Animal e_2	1,356	25,600	8.58	1,122	16,277	7.10
Diesel e_3	59	1,116	0.37	1,354	19,642	8.57
Electricity, e_4	0	0	0.00	44	638	0.28
Direct energy, E_1	4,017	75,954	25.42	4,740	68,763	29.99
Seeds, e_5	1,050	19,689	6.65	1,413	20,498	8.94
FYM, e_6	233	4,409	1.48	241	3,496	1.53
Fertilizer, e_7	5,947	1,12,535	37.64	5,730	83,125	36.27
Chemicals, e_8	283	5,355	1.79	78	1,132	0.49
Machinery, e_9	192	3,633	1.22	362	5,252	2.29
Canal e_{10}	4,079	77,187	25.82	6,400	92,845	40.51
Indirect energy, E_2#	11,784	2,22,808	74.58	14,224	2,06,248	90.03
Total Energy, E	15,801	2,98,762	100.00	18,964	2,75,111	120.02
Productivity, kg ha^{-1}	3,060		100.00	4,442		109.23
Production, tones		83,630			70,051	
Specific Energy, GJ ton^{-1}		3.57			3.93	
Energy Productivity, kgM		0.28			0.25	

E_1*= $e_1+e_2+e_3+e_4$, E_2# = $e_5+e_6+e_7-e_8+e_9+e_{10}$, $E = E_1+E_2$
(Source : Anonymous 1998, 2000)

Table 2. Operation-wise energy consumption pattern for kar paddy cultivation

Sources	1989-90		Percent to the 1989-90 Average	1997-98		Percent to the 1989-90 Average
	Average MJ ha^{-1}	Total GJ		Average MJ ha^{-1}	Total GJ	
Preparatory Cultivation	1,349	25,533	16.75	1,848	26,810	22,94
Sowing	254	4,799	3.15	276	4,002	3.43
Irrigation	4,330	81,931	53.74	6,842	99,255	84.93
Weeding	480	9,077	5.96	300	4,354	3.72
Fertilizer Application	85	1,608	1.06	120	1,744	1.49
Spraying	42	789	0.52	10	138	0.12
Harvesting and Threshing	1,516	28,682	18.82	1,877	27,231	23.30
Total	8,056	1,52,419	100.00	11,273	1,63,534	139.93

wise energy consumption for kar paddy cultivation. The results thus obtained were used for calculating the total energy consumption of the study zone. Regression model was fitted to bring out the relationship between the yield (Y) and total energy (e).

Results and Discussion

Source-wise energy consumption pattern for kar paddy cultivation

Source-wise energy consumption pattern for kar paddy cultivation is given in table1.

From the table, it is observed that the total energy for kar paddy cultivation varied from 15,890 MJ ha^{-1} in 1989-90 to 18,963 MJ ha^{-1} in 1997-98 resulting in the increase of paddy yield by 1382 kg ha^{-1}. Total energy spent in the zone has reduced from 2,98,983 GJ to 2,75,096 GJ in a span of eight years due to overall reduction in the cultivation area of kar paddy from 18,293 to 14,509 ha (Anonymous, 1989 and 1997).

The results indicate that there is lesser variation in human and animal energy usage and there is more variation in diesel energy usage as far as direct sources of energy is considered. Usage of electricity for paddy threshing was noticed in some of the farms in 1997-98. Consumption of direct sources of energy was around 25.42 percent of the total energy in 1989-90, and in 1997-98 it was around 30 per cent of total energy of 1989-90. Considerable increase in machinery usage in 1997-98 has resulted in more diesel energy consumption.

Energy utilized for seed has increased from 1050 MJ ha^{-1} to 1413 MJ ha^{-1} in order to have more biomass dynamics and yield. Much change was not noticed in farmyard manure consumption in the study period. There was very less change in fertilizer energy consumption, as the same dosage of fertilizer was used in both the periods. Usage of plant protection chemicals depends on the infestation of pests and diseases, which in turn depend on the local climatic conditions. Chemical use was much less in 1997-98 as the infestation of pests and diseases were very low due to non-conducive climatic conditions for the attack. Machinery usage in some farms has increased for tillage and threshing operations in 1997-98, resulting in one percent increase in machinery use over 1989-90. Basically, local climatic conditions and availability of water in the reservoirs influence the irrigation by canal. Dry weather conditions prevailed during 1997-98 prompted more use of canal water by about 15 percent, over the year 1989-90. The indirect sources of energy, which is the summation of energy sources *viz.* seed, FYM, fertilizers, chemical, machinery and canal was around 11,784 MJ ha^{-1} in 1989-90 and 14,224 MJ ha^{-1} in 1997-98.

The important aspect of paddy cultivation was the reduction in total production in the zone from 83,630 tonnes to 70,051 tonnes in eight years time due to reduction in area under cultivation. The specific energy consumption has reduced from 5.16 to 3.60 because of higher productivity and the energy productivity has increased from 0.19 to 0.23, which is a very significant consideration for the future energy planning.

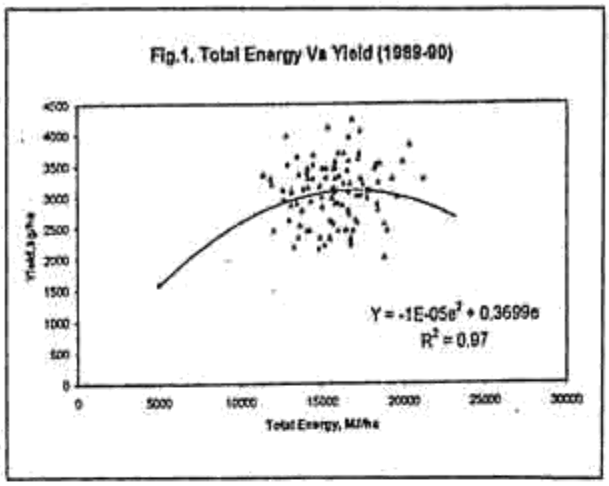
Operation-wise energy consumption pattern in paddy cultivation

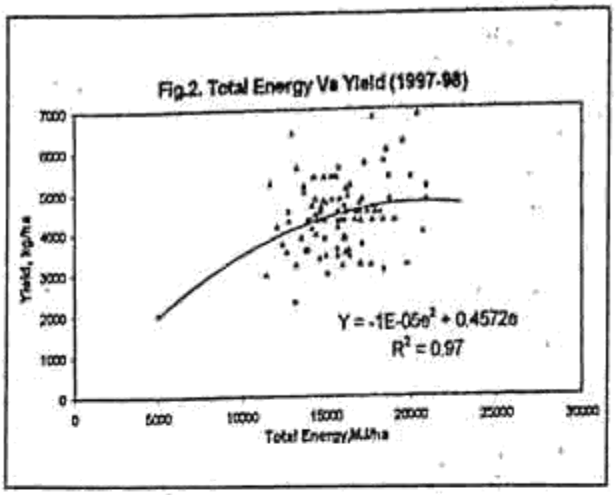
Operation-wise energy consumption pattern for Kar paddy is given in table 2. It is found out that the energy consumed for preparatory cultivation has increased by about 500 MJ ha^{-1} in 1997-98, which is an increase of around 6 per cent from 1989-90. Tractor usage for preparatory cultivation in 1997-98 has resulted in increase of energy consumption. An increase in (more than 2500 MJ ha^{-1}) irrigation energy was noticed because of the prevalence of dry weather condition during the crop growth period in 1997-98. Considerable reduction of energy consumption for weeding operation by about 2 per cent in 1997-98 was again attributed to dry weather conditions. Higher yield returns in the year has increased the energy contribution to harvesting and threshing operations by about 5 per cent over 1516 MJ ha^{-1} in 1989-90.

Spatial Variation in total energy and yield for kar paddy

The quadratic relationship between the total energy and yield was plotted for the year 1989-90 (Fig. 1) and 1997-98 (Fig. 2). From the figure 1, it is noticed that the energy utilization for Kar paddy, was ranged between 11,398 and 21,153 MJ ha^{-1}, and the yield was ranged between 2,030 to 4,236 kg ha^{-1} (John Gunasekar. J *et al.* 2001). A regression equation was also fitted for the quadratic model ($Y = -IE\text{-}05e^2 + 0.3699e$) and the R^2 value was found to be 0.97. From the figure it was also noted that beyond 17500 MJ ha^{-1} of energy consumption, the yield obtained was reducing.

It is also observed from the figure 2, that the total energy consumption and yield varied





from 11,450 to 20,899 MJ ha^{-1} and from 2,330 to 6,870 kg ha^{-1} respectively. The IC value for the regression model ($Y=-1E-05e^2+0.4572e$) was found to be 0.97. In 1989-90 almost all the farmers have adopted conventional practices while in 1997-98 the farmers have adopted improved practices. The improved practices have proved that the productivity was higher in 1997-98 when compared to 1989-90. It was understood from the figure 1 and 2, the wide variation in the energy consumption by each farmer was noticed in 1997-98 than in 1989-90 as the intensity of mechanization varied very much.

Conclusions

In the gap of eight years time, high rainfall zone witnessed a considerable shift towards the usage of machinery, which implies that the improved practices have been adopted in kar paddy cultivation. This has resulted in higher energy consumption and yield rate. It was noticed that the productivity level is proportionately reducing beyond certain limit of energy level. Hence, careful monitoring and management has to be followed to sustain the increasing trend of productivity level. Future recommendations for any improvements in the package of practices, *viz.* mechanization and irrigation practices have to be advocated after knowing the energy consumption scenario apart from cost and time saving factors.

Acknowledgements

The authors greatly acknowledge the financial assistance provided by ICAR to carry out the study under AICRP - ERAS scheme. They also acknowledge Tamil Nadu Agricultural University for giving all the necessary help in conducting the study.

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(Received: October 2001; Revised: December 2001)