gca effects showed high *sca* effects. The crosses ADT 37 X Co 41 (plant height, 100-grain weight and grain yield), ADT 37 X IR 50 (ear bearing tillers per plant, grain number per ear and 100-grain weight), ADT 37 X ADT 36 (grain number per ear and grain yield), Co 41 X IR 50 and Co 41 X ADT 36 (plant height) and IR 50 X ADT 36 (ear bearing tillers per plant, ear length and grain yield) showed significant and positive *sca* effects though one of the parents involved had low *gca* effects. These crosses can throw transgressive segregation in the segregating generation for effective selection.

Both additive as well as non-additive genetic components have been found to be important in governing the yield and its component in this study. So, biparental mating in the early generation among the selected lines or diallel selective mating as suggested by Jensen(1970) exploiting the available genetic male-sterile lines would be appropriate in our breeding programmes for the improvement of characters studied.

REFERENCES

BHANDARI, D.R. 1978. Line X tester analysis and its interaction with environment in American Cotton G. hirsutum L. **Madras Agric. J., 65**: 218-25.

GRIFFING, B.1956. A generalised treatment of the diallel cross in quantitative inheritance. **Heredity, 10**: 31-50.

JENSEN,N.F.1970. A diallel selection mating system for cereal breeding. **Crop Sci., 10**: 629-35.

PETHANI,K.V. and R.L. KAPOOR, 1984. Combining ability and its interaction with environment for grain yield in pearl millet. **Indian J.Agric.Sci., 54**: 87-92.

SINGH,R.P. 1980. Association of grain yield and its components in F_1 and F_2 populations of rice. **Oryza 17**: 200-4.

SINGH,R.P.,S.P. SINGH and R.V. SINGH 1980. Estimation of genetic component on variation inrice. **Oryza 17**: 24-7.

Madras Agric. J., 81(7): 373-376 July, 1994 https://doi.org/10.29321/MAJ.10.A01537

ENERGY MANAGEMENT IN SORGHUM BASED CROPPING SYSTEMS WITH BIO-DIGESTED SLURRY AND AZOSPIRILLUM

A.BALASUBRAMANIAN and P.MANICKASUNDARAM
Dept. of Agronomy, TNAU, Coimbatore.

Abstract

The results of the experiment conducted during 1982-1983 revealed that in the cropping systems, the maximum amount of energy flow was through irrigation (55%) followed by fertilizer (28.5%). The high intensity cropping system viz., sorghum-sorghum ratoon-maize-sunflower with itercrops gave the highest energy input, output and energy efficiency than conventional system. Energy efficiency improved by incorporation of biodigested slurry and inoculation of Azospirillum, under moderate level of N. Irrespective of the cropping systems, application of biodigested slurry at 10 t/ha with 75% recommended N + Azospirillum to each crop needed less specific energy.

At present, the crop production is highly correlated with inputs of fertilizer. The high intensive cropping systems have been reported to remove 500 to 700 kg of nutrients per ha per year. Hence increasing energy input-output ratio is important from the point of view of increasing costs of high energy inputs like fertilizers. Hence there is a need to lay more emphasis on the use of renewable source of energy i.e. recycling the Agricultural wastes and biofertilizers. With this view, a study was undertaken to assess the energy flow into the different sorghum based intensive cropping systems and to workout energy efficiency and specific energy.

MATERIALS AND METHODS

A field experiment was conducted at TNAU, Coimbatore, in clay loam soil with three different cropping systems viz; (C_1) - Sorghum - Finger millet - Cotton, (C_2) - Sorghum + Cowpea - Finger millet + Sunflower as border crop - Cotton + Blackgram, (C_3) - Sorghum + lab-lab-Sorghum ratoon + Blackgram - Maize + Soybean - sunflower. In the cropping systems three levels of organic manures and four fertiliser levels were tried in split plot design with the cropping system and manurial levels in main plot and fertiliser levels in sub plot with three replications. The energy used for different field operations, yield

Table 1. Energy distribution in different cropping systems %

	Cropping system	Irrigation	Manures and fertilizers	Pesticides	Human labour	Tools and animal draft	Seeds
C1 :	Sorghum (Co 23) - Finger millet (Co 11) (Feb - May) (June-Aug) Cotton (MCU 11) (Sep - Feb)	57.9	26.7	7.9	3.2	3.1	1.2
C2 :	Sorghum - Finger millet - Cotton + Cowpea (C152) + Sunflower + Black gram (Morden) (Co 4) (Feb - May) (June-Aug) (Sep-Feb)	56.9	26.2	7.8	3.5	3.2	2.4
C3 :	Sorghum + Sorghum (R) + Maize + Lab lab - black gram - Soybean (Co 9) (Co1) (Feb-May) (June-Aug) (Aug-Nov) Sunflower + Cowpea (Dec.-Feb) (F) (Col)	51.1	32.8	6.8	3.5	3.1	2.7
	Mean	55.3	28.6	7.5	3.4	3.1	2.1

of grain and straw were recorded seperately for each crop.

From these data, total energy input in output were computed by using the energy constants proposed by Mittal *et al*., (1985). The energy input and out put were expressed in M.J./ha.

$$\text{Energy efficiency ratio} = \frac{\text{Energy output (M.J./ha)}}{\text{Energy input (M.J./ha)}}$$

Table 2. Energy input and output of different cropping systems

	Energy (10^3 M.J./ha) Input	Output
I. Cropping systems		
C1 : Sorghum - fingermillet-cotton	48.075	464.4
C2 : Sorghum - fingermillet - Cotton with intercrops	48.683	565.6
C3 : Sorghum - Sorghum ratoon - Maize -Sunflower with intercrops	56.364	846.4
II. Manurial levels		
M0 : No menure	49.243	573.1
M1 : FYM 10 t/ha	51.588	673.6
M2 : Biodigested slurry @ 10 t/ha	52.291	565.6
III. Fertilizer levels		
F0 : No fertilizer	38.103	393.3
F1 : Recommended NPK	57.420	714.6
F2 : 75% N + Azospirillum + 100% P and K	53.058	688.7
F3 : 100 % N to each crop + 100% PK to first crop	55.582	705.2

Specific energy of each system was calculated in forms of energy required to produce a tonne of economic yield and expressed as M.J./t.

RESULTS AND DISCUSSION

Energy distribution

In the cropping systems, the maximum amount of energy flow was through irrigation (55%). It was higher in the conventional system (C_1) (57.9%) than in C_3 system (51.1%). The next highest component of energy flow into the cropping system was through fertilizer (28.5%). Highest fertilizer energy was supplied in C_3 system and the lowest in C_1 and C_2 systems because of relatively higher amount of fertilizer usage in this system. Third major amount of cultural energy was pesticides (7.5%) which was maximum in c_1 system followed by C_2 and C_3 systems since more pesticides were used for cotton in C_1 and C_2 systems. The least amount of energy flow was through seeds, in which C_3 system recorded the maximum followed by C_2 and C_1 systems (Table 1).

Energy input and output :

Total energy input in C_1 system ranged from 34.859 x 10^3 M.J/ha to 54.589 x 10^3 M.J/ha; in C_2 system, it ranged from 35.673 x 10^3M.J/ha to 54.412 M.J/ha and in C_3 system, from 37.657

Table 3. Energy efficiency and Specific energy (MJ/t) of different multiple cropping systems

Fertilizer levels/ Systems and Manures		Energy efficiency					Specific energy (MJ/T)				
		F0	F1	F2	F3	Mean	F0	F1	F2	F3	Mean
C1	M0	7.47	9.34	9.90	9.55	9.07	6373	5157	4830	5061	5255
	M1	8.70	9.68	10.14	9.89	9.60	5608	4930	4569	4797	4976
	M2	9.90	10.10	10.80	10.28	10.27	5167	4769	4443	4646	4756
	Mean	8.69	9.71	10.28	9.91	9.65	5716	4952	4614	4835	5029
C2	M0	9.68	11.12	11.17	11.33	10.83	5265	4644	4268	4499	4669
	M1	11.18	11.71	12.37	11.95	11.80	4520	4377	4003	4228	4282
	M2	11.69	12.14	11.94	12.39	12.04	4262	4589	3990	4229	4268
	Mean	10.85	11.66	11.83	11.89	11.56	4682	4537	4087	4319	4406
C3	M0	10.14	14.81	15.56	15.16	13.92	3232	2636	2570	2708	2793
	M1	11.97	15.45	16.50	15.77	14.92	2840	2368	2241	2352	2450
	M2	12.43	15.72	16.57	16.04	15.19	2627	2433	2267	2396	2431
	Mean	11.51	15.33	16.21	15.66	14.68	2900	2488	2359	2485	2558

$\times 10^3$ M.J/ha to 66.170 $\times 10^3$ M.J/ha. Total energy input in the conventional system (C_1) was 48.075 $\times 10^3$ M.j/ha, which was about two thirds of energy input of C_3 system. Under recommended level of NPK to each crop with annual addition of sundried biogas slurry @ 10 t/ha, the energy flow was maximum in C_3 system (66.170 $\times 10^3$ M.J/ha) and was the least in C_1 system (54.589 $\times 10^3$ M.J/ha) (Table 2.) Among the three systems evaluated the total energy output was maximum in high intensive cropping system (C_3) (846.4 $\times 10^3$ M.J./ha) followed by C_2 (565.6 x 103 M.J./ha) and C_1 system (464.4 $\times 10^3$ M.J./ha). The highest amount of energy ouput 1040 $\times 10^3$ M.J./ha) was recorded in C_3 system under recommended level of NPK to each crop with annual addition of sundried biogas slurry @ 10 t/ha (Table 2).

Energy efficiency

Of the three cropping systems evaluated, the high intensive system, sorghum-sorghum ratoon-maize-sunflower with intercrops achieved an energy input-output ratio of 14.68 followed by C_2 system with the ratio of 11.56. The conventional system, sorghum-fingermillet- cotton, was the least. Energy efficiency improved by incorporation of farm yard manure and sundried biogas slurry and also with application of fertilizers compared to control. Lower levels of NPK recorded higher energy efficiency than recommended level of NPK. Interactions showed that C_2 system recorded higher input-output ratio under biogas slurry with 100% N to each crop and 100% PK to the remaining crops (12.39), whereas C_1 and C_3 systems registered higher ratios at 75% N with Azospirillum + 100% NK (10.8 and 16.57 respectively). Sundara (1985) reported that an energy input-output ratio of 16.98 in sugarcane-ratoon-fingermillet-cotton system under optimum agronomic practices and higher dose of N reduced the energy efficiency, whereas Pimental (1980) reported an energy efficiency of around 3 for corn production in USA. Sorghum, sorghum ratoon and maize were the principal crops in the system, which are established as high energy fixing crops, therefore energy input-output ratio in C_3 system was higher.

Specific energy

Specific energy (M.J/tonne of economic yield) was maximum in the case of conventional system (C_1) followed by C_2 and C_3 systems. Sorghum fingermillet-Cotton system was least efficient. This is evident from the fact that it required 5029 M.J of energy to produce one tonne of economic yield whereas sorghum-fingermillet- cotton with intercrops (C_2) system required 4406 MJ and C_3 system 2558 M.J./ha.

Specific energy was minimum in incorporation of organic manures and addition of fertilizer compared to respective control. Annual application of sundried biogas slurry at 10 t/ha required the least specific energy (3818 M.J/ha) whereas FYM and no manure needed 3903 and 4272 M.J/t respectively. With regard to the fertilizer levels, 75% recommended N + Azospirillum + 100% PK required less specific energy. Irrespective of the cropping systems, the treatment biogas slurry with 75% of recommended N + Azospirillum inoculation to each crop needed less energy. Thus considerable amount of energy can be saved by combined application of bio digested slurry with Azospirillum.

REFERENCES

MITTAL, V.K., J.P. MITTAL and K.C. DHAWAN, 1985. Research digest on energy requirements in agricultural sector. ICAR/AICARP/ERAS/85.

PIMENTAL, D. 1980. Energy inputs for production, formulation, packaging and transport of various pesticides. in : **Handbook of energy utilisation in agriculture.** D.Pimental (ed.) CRC Press. BOCs Raton Fl. pp. 35-42.

SUNDARA, B. 1985. Short duration sugarcane based sequential cropping systems. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Madras Agric. J., 81(7): 376-378 July, 1994

NUTRIENT MANAGEMENT IN GROUNDNUT-SORGHUM CROP ROTATION

V. GEETHALAKSHMI, A. CHRISTOPHER LOURDURAJ, T.S. RAVEENDRAN, A.JOHN JOEL and K. RAJAMANICKAM.

Agricultural Research Station, Aliyarnagar.

ABSTRACT

A field experiment was conducted at Aliyarnagar involving groundnut-sorghum crop rotation to study the effect of nutrients applied to groundnut on the succeeding sorghum crop. The results revealed that application of 45 kg/ha phosphorus along with the recommended doses of other nutrients to groundnut, minimised the fertiliser requirement of sorghum to the tune of 1/3rd of the recommended dose.

The beneficial effects phosphorus application to groundnut are well established. Besides increasing the yield, P fertilisation also improves the synthesis of oil and its quality in groundnut (Pasricha *et al.* 1988). Usually the fertiliser requirements of crops in a crop rotation are worked out on the basis of individual crops without taking into effect the direct, residual and cumulative effects of fertilisers applied to the crops in the rotation. Smartt (1976) reported that groundnut is capable of making good use of residual phosphorus and potassium from fertilisers applied to other crops. Hence a field experiment was conducted to study the nutrient requirements in a groundnut-sorghum crop rotation.

Table 1. Effect of levels of phosphorus on groundnut

Treatments	Dry Pod yield (Kg/ha)	No.of pods per plant	Shelling per cent	100 kernel weight (gm)	Sound matured kernel (per cent)	Net return (Rs/ha)	Benefit-Cost ratio
No P_2O_5	722	8.3	65.7	28.7	60.3	1337	1.32
15 kg P_2O_5/ha	946	10.3	67.3	29.4	62.3	2833	1.67
22.5 kg P_2O_5/ha	1043	11.2	70.3	29.6	64.9	3396	1.77
30 kg P_2O_5/ha	1159	11.8	72.6	30.1	66.8	4132	1.91
45 kg P_2O_5/ha	1315	13.2	74.2	30.4	69.5	5092	2.08
SE D	28.3	0.78	0.92	0.35	1.21	343.9	0.05
CD	61.7	1.70	2.00	0.77	2.64	749.6	0.11

MATERIALS AND METHODS

An experiment was conducted at the Agricultural Research Station, Aliyarnagar on sandy loam soil with a soil p^H of 8.1 and available N, P_2O_5 and K_2O as 172.2 (low), 16.4 (medium) and 340.0 (high) respectively. Groundnut crop was raised in Kharif (June), followed by a sorghum crop in summer season (January). Groundnut-Sorghum rotation was followed in succession for three times in the same field from 1987 to 1990. The trial was laid out in split plot design with four replications. The main plot treatments consist of O, 50, 75, 100 and 150 Per cent of the recommended dose of P_2O_5. The sub plot treatments consist of control (no fertilisers),