CROP YIELDS AND ECONOMICS OF SHORT DURATION SUGARCANE BASED SEQUENTIAL CROPPING SYSTEMS*

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Field studies were conducted at Sugarcane Breeding Institute, Coimbatore during 1982-84 on alfisol to evaluate four short duration sugarcane based sequential cropping systems (1. short duration sugarcane/1st ratoon/2nd ratoon; 2. short duration sugarcane/ 1st ratoon/finger millet/cotton; 3; finger millet/short duration sugarcane/1st ratoon/wheat; 4. finger millet/maize/short duration sugarcane/1st ratoon) fot their production potential and economics vis-a-vis the conventional practice of a plant and a ratoon crop with a normal duration sugarcane in a cropping cycle of 24 months. All the short duration sugarcane based cropping systems were more productive and profitable than the conventional system. The sequence 'short duration sugarcane/1st ratoon/finger millet/cotton was best producing 195.6 t of cane. 3.8 t of finger millet and 4.07 t of seed cotton/ha compared to 203.6 t of cane alone in the conventional system. Sequence 2 gave a net return of Rs. 48,242/ha (benefit/cost ratio = 3.13) compared to 23,640/ha in the conventional system (benefit/cost ratio = 2.47).

One of the recent developments in sugarcane research is the evolution of short duration sugarcane varieties which ripen in about 8 months as against 12 months normally required. These varieties are of much relevance and great significance in the context of the present thrust on increasing productivity. Multiple cropping would be possible with these varieties. Conventionally, farmers raise one plant and a ratoon crop in 24 months with a 12 months variety. But with short duration varieties, three crops of sugarcane (one plant + two ratoons) are possible. Alternatively a plant, a ratoon and some other rotational crop / crops in the remaining 8 months can be raised. These varieties being generally rich in sucrose, can be utilised to improve sugar recoveries and extend the crushing season by appropriate planting and harvesting schedules. In the present study effort was made to fit short duration sugarcane into cropping systems and evaluate short duration sugarcane based sequential cropping systems for their production potential and economic advantage in comparison with conventional system.

MATERIALS AND METHODS

Field studies were conducted at Sugarcane Breeding Institute, Coimbatore during 1982-84 on alfisol on pH 7.8, containing 175.4, 80.4 and 627.8 kg available N, P_2O_5 and K_2O / ha respectively. The cropping systems evaluated were :

(1) short duration sugarcane / 1st ratoon / 2nd ratoon.

(2) short duration sugarcane / 1st rat toon / finger millet / cotton ;

(3) finger millet / short duration sugarcane / 1st ratoon / wheat ;

(4) finger millet / maize / short duration sugarcane / 1st ratoon and

(5) normal duration sugarcane / 1st-ratoon.

The short duration sugarcane in sequence 1-4 was raised under 60 and 90 cm row spacings and at 100, 150 200 and 250kg N/ha/crop in a split plot arrangement having spacings in the main plots and N levels in the sub-plots. Other sequential crops were raised with their recommended package of practices.

The crop sequences were laid out in a randomised block design replicated 3 times. Each sequence was raised in strips consisting of 8 plots measuring 6.1 x 7.2 m (gross). For sugarcane yield data a net plot of 6.1 x 5.4 m was made use of. In other crops yield data were collected from the area excluding one border row on either side.

The crop varieties used were : short duration sugarcane Co A 7601, normal duration sugarcane Co 6304, finger millet Co 11, maize UMH 3, cotton LRA 5166 and wheat HD 2189. Short duration sugarcane was uniformly supplied with 75 kg P_2O_5 and 120 kg K_2O / ha / crop. Phosphorus was applied as basal and N and K were top dressed on 30, 60 and 90 days after planting in equal splits. Ratoons were top dressed on 20 and 50 days after ratooning in equal splits. Finger millet in sequence 2, 3 and 4 were raised by transplanting 20 days old seedlings. Cotton in sequence 2 was raised in the finger millet stubbles. Cultivation practices for the crops except short duration cane were as per the recommended package of practicies. Normal irrigations were given and plant protection was need-based. The cropping programme is presented below :

Sequence	Crops	Cropping period		Total field duration (days)
		From	To	
1.	Short duration sugarcane (plant)	27-2-82	28-10-82	
	First ratoon	29-10-82	11-6-83	720
	Second ratoon	12-6-83	17-2-84	
2.	Short duration sugarcane (plant)	27-2-82	28-10-82	
	First ratoon	29-2-83	11-6-83	726
	Finger millet	16-6-83	7-9-83	
	Cotton	8-9-83	27-2-84	
3.	Finger millet	4-3-82	26-5-82	
	Short duration sugarcane	16-6-82	23-2-83	687
	First ratoon	24-2-83	31-10-83	
	Wheat	16-11-83	25-2-84	
4.	Finger millet	4-3-82	26-5-82	
	Maize	16-6-82	22-9-82	676
	Short duration sugarcane	13-10-82	11-6-83	
	First ratoon	12-6-83	20-2-84	
5.	Co 6304 (plant)	27-2-82	23-2-83	720
	First ratoon	24-2-83	17-2-84	

The cropping systems were assessed for yield potential and economics. Sugarcane juice quality (Brix, sucrose and purity) was determined as per the procedure described by Meade and Chen (1977). Commercial cane sugar per cent (CCS %) and sugar yield were calculated as per the following formulae :

$$CCS = Sucrose\ \% - 0.4\ (Brix\ \% - sucrose\ \%)\ 0.73$$

$$Sugar\ yield = \frac{CCS\ \%\ x\ cane\ yield}{100}$$

Gross returns were calculated based on the prevailing market prices of main and bye-products. Total variable costs (TVC) were worked out for each sequence under different treatments to short duration sugarcane. From gross return and TVC, net returns and return per rupee invested (benefit / cost ratio) were calculated. Income Equivalent Ratio (IER) (Andrews and Kassam, 1976) of the short duration sugarcane based systems was worked out considering an IER of 1 for the gross return obtained in the conventional system. Marginal Benefit Cost Ratio (MBCR) was worked out as indicated below*

Where E refers to experimental pattern (sequence 1 to 4), F to farmer's pattern (sequence 5), MVP to marginal value product and MVC to marginal value cost (Palaniappan, 1985). Net return per day (per day income) was calculated based on 2 year cropping period.

RESULTS AND DISCUSSION

Performance of short duration sugarcane in different sequences was best under 60 cm row spacing and 200 kg N/ha. Therefore, data pertaining to short duration sugarcane based systems under this treatment are only presented and compared with the conventional system.

Agricultural yields

Main economic yields (Table 1) in the cropping systems were diverse in nature with varying economic values. Therefore, comparison based on total agricultural yields does not show the actual merit of one over the other. However, sequence 1 (SEQ 1 and 5 were the mono crop sugarcane sequences. Total cane yield from 3 crops in SEQ 1 was 254.7 t/ha. in 2 years whereas the conventional system (SEQ 5) has yielded only 203.6 t/ha. Thus, the 3-crop short duration system has given 25 per cent more cane yield. Sugar yield in SEQ 1 was 28.22 t/ha compared to 22.96 t in SEQ 5.

Based on cane yield / month, all the short duration sequences were better than the conventional system. In short duration sugarcane based systems, it ranged from 10.61 t/ha in SEQ 1 to 12.28 t/ha in SEQ 3 as against 8.48 t in SEQ 5.

On an average, about 6 per cent reduction in the cane yield was observed in the first ratoons of short duration cane compared to the plant crops.

$$* \ MBCR = \frac{Gross\ return\ (E) - Gross\ returns\ (F)}{TVC\ (E) - TVC\ (F)} = \frac{MVP}{MVC}$$

But there was drastic reduction in yield of about 40 per cent in the second ratoon (SEQ 1). This is attributable to large gaps in the crop. Besides, yield reductions in the ratoons is of common occurrence in India due to depletion in soil fertility status. Improving ratoon yields, therefore, is essential for the overall increased productivity of 3-crop sequence with short duration cane.

All the short duration sugarcane crops, except 2nd ratoon in SEQ 1, have given above 16 per cent sucrose. This is exactly in line with the quality requirement of short duration cane as defined by Sugarcane Breeding Institute (Anon, 1981). June planting (SEQ 3) or June ratooning (SEQ 4) has given higher juice sucrose percent. This is because of more favourable weather conditions available during the ripening phase of these crops.

Total agricultural yield was highest in SEQ 1 because of heavy tonnage of sugarcane. But from the money value view point, SEQ 2 was best since it had 2 commercial crops (sugarcane and cotton) and a grain crop (finger millet). In this sequence 195.6 t of cane, 3.83 t of finger millet and 4.07 t of seed cotton yields were obtained.

Finger millet yields in SEQ 2, 3 and 4 were comparable with the best yields obtained with the variety in this region. Summer finger millet (SEQ 3 and 4) has given slightly higher yield than the *kharif* crop (SEQ 2). This was because of higher harvest index of the summer crop (34% compared to 26% in *kharif*). Yield of maize (SEQ 4) was also normal to the region. But the yield of wheat (SEQ 3) was poor.

This can be attributed to the mild and short winter season of the location with limited growing period. There was also some rains during February coinciding with the grain filling stage of wheat.

SEQ 2, 3 and 4 have also yielded bye-products. In SEQ 2, 10.5 t of finger millet straw and 6.7 t of cotton stalks were obtained. SEQ 3 and 4 have yielded 11.2 and 11.6 tonnes of straw respectively.

Economics

The diverse nature of the crop yields present a problem for proper evaluation. Hildebrand (1976). opined that the 'doller sense' (economics) is the best means of measuring output in the cropping system, especially involving diverse crops. Gross returns (Table 2) was highest (Rs. 70,841/ha) in sequence 'short duration sugarcane/ 1st ratoon/finger millet/cotton' (SEQ 2). Not much variation was observed in other short duration based sequences. The conventional system (SEQ 5) resulted in the least gross returns (Rs. 39,708/ha) and 3 crop sugarcane sequence (SEQ 1) gave Rs. 49,659/ha. The SEQ 2 was much better, particularly because of high value cotton.

Total variable cost was highest (Rs. 22,599/ha) for SEQ 2 and did not differ much in other short duration sugarcane based systems, while the conventional system involved relatively lesser TVC (Rs. 16,068/ha). Short duration sugarcane sequences with higher cropping intensity index required greater inputs leading to higher TVC. Sequence 2 was more labour and input intensive system and hence

Table 1. Economic yields in the cropping systems

Sequence and components crops	Cropping intensity (%)	Crop yields (main) (t/ha)	Juice sucrose (%)	Total cane yield in the system (t/ha)	Cane yield/ month (t/ha)	Total sugar yield (t/ha)	Bye-products (t/ha)
Sequence 1	150						
SD sugarcane		101.50	16.34			11.47	
2nd ratoon		96.39	16.39	254.7	10.61	10.97	
		56.77	15.24			5.78	
		___254.66				___28.22	
Sequence 2	200						
SD Sugarcane		102.50	16.38			11.62	
1 st ratoon		93.12	16.42			10.62	
Finger millet		3.83	—			—	10.5 (straw)
Cotton (Kappas)		4.07		195.6	12.23	—	6.7 (cotton stalks)
		___203.52				___22.24	
Sequence 3	200						
Finger millet		3.96				—	7.3 (straw)
SD sugarcane		104.49	17.31			12.46	
1st ratoon		93·03	16.38			10.28	
Wheat		1.70	—	196·5	12.28	—	3.9 (straw)
		___202.18				___22.74	
Sequence 4	200						
Finger millet		3.97				—	7.3 (straw)
Maize		3.77				—	4.3 (straw)
SD sugarcane		95.51	16.20			10.72	—
1 st ratoon		90.41	17.01	185.9	11.82	10.51	
		___193·66				___21.23	
equence 5	100						
ND sugarcane	100	103.1	16.03			11.45	
1st ratoon		100.5	16.62	203.6	8.48	11.51	
		___203.6				___22.96	

SD = Short duration; ND = Normal duration

Table 2. Economics of the short duration sugarcane based cropping systems

	Sequence	Gross returns (Rs. / ha)	Total variable costs (Rs. / ha)	Net returns (Rs. / ha)	Benefit / cost ratio	Net returns per day (Rs. / ha)	IER	MBCR
1.	SD sugarcane / 1st ratoon / 2nd ratoon	49659	20996	28663	2.37	39.81	1.26	2.02
2.	SD sugarcane / 1st ratoon / finger millet / cotton	70841	22599	48242	3.13	65.45	1.78	4.77
3.	Finger millet / SD sugarcane / 1st ratoon / wheat	50498	20734	29764	2.44	43.32	1.27	2.31
4.	Finger millet / maize / SD sugarcane / 1st ratoon	51332	20727	30605	2.48	45.27	1.29	2.49
5.	Normal duration sugarcane / 1st ratoon	39708	16068	23640	2.47	38.83	1.00	—
	CD at 5%	1060	—	869	—	—	—	—

SD = Short Duration

IER = Income Equivalent Ratio

MBCR = Marginal Benefit Bost Ratio

Market price assumed : Sugarcane Rs. 195 / t, Cotton Rs. 600 / q.

Finger millet Rs. 1,80 / kg. Wheat Rs. 2.30 / kg. Maize Rs. 1,80 / kg

Cotton stalks Rs. 5 / q, Straw Rs. 100 / 5

TVC was slightly higher. Nevertheless, TVC of cotton in SEQ 2 was kept low as it was sown in the finger millet stubbles avoiding the expenditure on the land preparation. Besides, cotton was given need-based plant protection sprays only.

All the short duration sugarcane based system gave higher net returns than the conventional system. Highest net return (Rs. 48,242/ha) was in SEQ 2 followed by SEQ 4, 3 and 1 among which the differences were marginal, and least net return was in the conventional system (Rs. 23,640/ha). Higher net returns were possible in short duration sugarcane based systems due to increased economic yields. SEQ 2 with high value cotton was most profitable because of very high gross returns with only slight increase in the cost of cultivation.

Benefit/cost ratio provides an estimate of the benefit a farmer derives for the expenditure he incurred in adopting a particular cropping system. This ratio must be at least 2.00 (Palaniappan, 1985). All the cropping systems evaluated exhibited higher ratio than this critical limit. SEQ 2 was best with a ratio 3.13 compared to 2.47 in SEQ 5. Per day net return was also highest in SEQ 2. Calculated on the basis of 365 days, this index shows the efficiency of the cropping system in monetary terms accounting the idle days too. In terms of IER, short duration sugarcane based systems have shown land advantages of 0.25 ha (SEQ 1) to 0.78 ha (SEQ 2). IER in SEQ 2 is 1.78 which indicates that gross monetary income obtained in 1 ha through this system is equal to that obtained in 1.78 ha of

land through SEQ 5. The concept of IER is generally employed for evaluating inter cropping systems. However, it has been used here to compare the new high intensity short duration sugarcane based sequential cropping systems against the conventional low intensity mono-cropping of sugarcane. MBCR which helps to evaluate a series of alternatives to the existing pattern and select the most remunerative pattern to the farmers was highest (4.77) in the SEO 2. Thus all these indices clearly show the economic advantages of short duration sugarcane based cropping systems over the conventional system. Sequence 2 with highest values for various indices was the best system for the agro-climatic conditions of Coimbatore.

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