



RESEARCH ARTICLE

Delineation of Efficient Cropping Zone for Sugarcane over the Southern Indian States

Gowtham, R.^{1*} Geethalakshmi, V.² and Panneerselvam, S.³

^{1*}Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore – 641 003, India

²Directorate of Crop Management, Tamil Nadu Agricultural University, Coimbatore – 641 003, India

³Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore – 641 003, India

ABSTRACT

Sugarcane is an important cash crop, contributing to 4.6 per cent of total agricultural output. In a few regions, though sugarcane had widespread area, the productivity is very less. In a few other regions, the productivity is very high but acreage under sugarcane is low. This warrants delineation of effective cropping zones for sugarcane. District wise statistics on area, production and productivity of sugarcane for southern Indian states was collected to compute Relative Spread Index (RSI) and Relative Yield Index (RYI) to classify the zones into Most Efficient Cropping Zone (MECZ), Area-Efficient Cropping Zone (AECZ), Yield Efficient Cropping Zone (YECZ) and Inefficient Cropping Zone (IECZ). Analysis indicated that the maximum efficient cane growing zone is in Tamil Nadu, followed by Karnataka, Andhra Pradesh and Telangana. Sugarcane is not preferred in Kerala due to the prevailing climatic conditions. This analysis helps in the identification of options for improving the sugarcane area and production

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INTRODUCTION

Human consumption of sugar is mainly met from sugarcane (*Saccharum officinarum*), a C4 crop, grown throughout the world for its sugar, bioenergy and other useful by-products (De Souza *et al.*, 2008). In Indian agricultural sector, sugarcane is an important cash crop in India and grown in an area of about 4.5 million ha occupying 3.7 per cent of the area and contributes to around 4.6 per cent of the total value of agriculture output (Anon, 2017a). Total sugarcane production reported in India was 306 million tonnes catering to the need of about 731 sugar factories (Anon, 2017a). The demand for food grains as well as another crop-based produces are increasing due to the enhancing population. Already, the available per capita arable land has reduced from 0.22 ha to 0.15 ha from 1991 to 2011 (Anon, 2015) due to increased pressure on land resources for non-agricultural uses which will have serious implications on food security. The declining trend of sugarcane production continued during 2016-17 as it fell from 348 million tonnes in 2015-16 to 306 million tonnes in 2016-17. There are certain key issues faced by the cane and sugar sector which need urgent attention to making the sector more efficient and for enhancing sugarcane and sugar production. The scope for the horizontal expansion of the cropped area is limited. The crops adaptability

to a particular region determines the productivity of the concerned crop. However, in most of the cases, the realized yield of crops are much lower than the achievable potential yield or in some of the other areas, the spread of the area is very low but the yield of the crops are much higher. Both the cases are not good for making the state self-sufficient. Even though a particular crop had wide spread in that region due to many obvious reasons, the productivity might not be high (Koppad and Khan, 1996). It is important to identify efficient cropping zone for important crops such as sugarcane. In this context an attempt was made to identify efficient cropping zone for sugarcane when such zone is identified, it is possible to introduce hi-tech agriculture to increase the productivity still further.

MATERIAL AND METHODS

District wise statistics on area, production and productivity of sugarcane for Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Telangana were collected for the years from 2007-08 to 2016-17 from the (Anon, 2017b). From the collected information, Relative Spread Index (RSI) and Relative Yield Index (RYI) were computed by using the following formula as suggested by Kanwar (1972), Sanbagavalli *et al.* (2002) and Arulmathi (2016).

*Corresponding author's e-mail: gowtham.acrc@gmail.com

The area under sugarcane expressed as % of the total cultivable area in the district

$$RYI = \frac{\text{Area of sugarcane expressed as \% to the total cultivable area in the State}}{\text{Area of sugarcane expressed as \% to the total cultivable area in the district}} \times 100$$

Mean yield of sugarcane in a district (t/ha)

$$RSI = \frac{\text{Mean yield of sugarcane in a district (t/ha)}}{\text{Mean yield of sugarcane in the state (t/ha)}} \times 100$$

By comparing the computed values of RYI and RSI, different cropping zones were classified as detailed below at the district scale over the southern Indian states.

RYI value	RYI category	RSI value	RSI category	Cropping zone	Reference
>100	High	>100	High	Most Efficient Cropping Zone (MECZ)	
< 100	Low	>100	High	Area Efficient Cropping Zone (AECZ)	Arulmathi (2016)
>100	High	< 100	Low	Yield Efficient Cropping Zone (YECZ)	
< 100	Low	< 100	Low	Not Efficient Cropping Zone (NECZ)	

The districts that have <1% of the sugarcane cultivated area in the total cultivable area was considered as non-sugarcane districts and excluded from this analysis. As per this assumption, none of the districts in Kerala had qualified as sugarcane cultivation districts. Hence, the entire Kerala state in southern India was not considered for delineation of efficient sugarcane cultivation zone.

RESULTS AND DISCUSSION

Analysis on delineation of efficient growing zone of sugarcane in southern India indicated that the maximum cane growing area is in Tamil Nadu state followed by Karnataka and Andhra Pradesh, Telangana has only three cane growing districts and sugarcane is not grown in Kerala in any of the

Table 1. Efficient sugarcane cropping zone over Tamil Nadu (2007-08 to 2016-17)

District	Sugarcane Area (ha)	Total sugarcane Production (Tonnes)	Yield (t/ha)	Cultivable area (ha)	% of sugarcane area to total cultivable area	RSI	RYI	Zone classification
Cuddalore	33415	3740613	112	303673	11	201	107	MECZ
Erode	29579	3533044	118	209414	14	258	113	MECZ
Namakkal	15045	1961204	131	193495	8	142	125	MECZ
Perambalur	9641	999259	108	116808	8	151	104	MECZ
Theni	8265	1082279	125	124602	7	121	120	MECZ
Villupuram	56142	6280123	111	385448	15	266	106	MECZ
Coimbatore	6060	695299	121	192551	3	57	116	YECZ
Dindigul	5375	585254	106	226043	2	43	102	YECZ
Kanchipuram	4864	697073	114	122646	4	72	109	YECZ
Madurai	5007	630266	113	126206	4	72	108	YECZ
Pudukkottai	6822	756366	109	140289	5	89	105	YECZ
Thanjavur	11504	1204176	105	264268	4	80	101	YECZ
Thiruvallur	6733	773886	113	139014	5	88	108	YECZ
Ariyalur	7796	800700	91	108833	7	131	87	AECZ
Dharmapuri	16509	1474863	87	199143	8	151	83	AECZ
Karur	6310	643598	100	86878	7	133	96	AECZ
Tiruvannamalai	26418	2429417	88	246014	11	196	85	AECZ
Vellore	17477	1463917	85	196494	9	162	81	AECZ
Nagapattinam	3748	333659	89	267770	1	26	86	IECZ
Salem	10180	1012240	99	276367	4	67	94	IECZ
Sivaganga	4988	481040	96	106677	5	85	92	IECZ
Tiruchirappalli	5403	572927	102	170732	3	58	98	IECZ
Tirunelveli	4102	394688	96	176089	2	43	92	IECZ
Tiruppur	5772	636952	97	184979	3	57	93	IECZ
Virudhunagar	3282	335006	101	150408	2	40	97	IECZ

Tamil Nadu state Area- 2.15 lakh ha; Production- 22.40 lakh tones; Productivity- 104 t/ha. District where sugarcane area was insignificant (<1% of the cultivable area): Tuticorin, Thiruvallur, The Nilgiris, Ramnad, Kanniyakumari, Krishnagiri

districts except Idukki and Palghat, that also only in less than one per cent of the area (Fig. 1).

Sugarcane cropping Zones of Tamil Nadu

In Tamil Nadu, the area under sugarcane cultivation was 2.15 lakh hectares with a production of 22.4 lakh tonnes and productivity of 104 t/ha. Maximum sugarcane area was registered in Villupuram district (56142 ha), followed by Cuddalore (33415 ha), Erode (29579 ha) and Tiruvannamalai (26418 ha) districts contributing

to almost 48% of the total sugarcane production of the state (34 million tonnes). In terms of productivity, Namakkal was top in the list with 131 tonnes of cane/ha followed by Theni (125 t/ha) and Coimbatore (121 t/ha). Villupuram, Cuddalore, Madurai, Thiruvallur, Kanchipuram and Erode districts recorded sugarcane productivity of 111 to 120 t/ha, while districts such as Karur, Virudhunagar, Tiruchirappalli, Thanjavur, Dindigul, Perambalur and Pudukkottai registered 100 – 110 t/ha. Relative spread index values indicated that

Table 2. Efficient sugarcane cropping zone over Karnataka (2007-08 to 2016-17)

District	Sugarcane Area (ha)	Total sugarcane Production (Tonnes)	Yield (t/ha)	Cultivable area (ha)	% of sugarcane area to total cultivable area	RSI	RYI	Zone classification
Bagalkot	66743	6347681	95	581425	12	389	107	MECZ
Chamarajanagar	9242	921777	95	208060	4	150	107	MECZ
Mandya	24858	2984350	119	266345	9	316	134	MECZ
Davangere	8758	913755	110	457718	2	65	124	YECZ
Mysore	9592	1024943	105	509225	2	64	119	YECZ
Shimoga	6824	770937	110	260532	3	89	124	YECZ
Bijapur	29610	2258281	74	955873	3	105	84	AECZ
Bidar	26586	1783492	67	418598	6	215	76	AECZ
Belgaum	143094	12289753	85	1023077	14	473	96	AECZ
Haveri	4357	378734	80	424673	1	35	90	IECZ
Gulbarga	13524	794263	60	1128939	1	41	68	IECZ
Uttar kannad	2289	179586	81	123747	2	63	92	IECZ

Karnataka state Area- 4.40 lakh ha; Production- 33.44 lakh tones; Productivity- 76 t/ha. District where sugarcane area was insignificant (<1% of the cultivable area): Kodagu, Raichur, Chikballapur, Dakshin kannad, Gadag, Udupi, Yadgir, Bengaluru urban, Chitradurga, Koppal, Tumkur, Chikmagalur, Ramanagara, Bangalore rural, Kolar, Bellary, Dharwad, Hassan

the area spread was more in Villupuram, Erode, Cuddalore, Tiruvannamalai, Vellore, Dharmapuri, Perambalur, Namakkal, Karur, Ariyalur and in Theni districts. Relative yield index was more than 100 per cent in Namakkal, Theni, Coimbatore, Erode, Kanchipuram, Thiruvallur, Madurai, Cuddalore, Villupuram, Pudukkottai, Perambalur, Dindigul and

Thanjavur districts indicating the better performance of sugarcane crop. Efficient cropping zone computed based on the combined performance of RYI and RSI indicated that most efficient cropping zone (MECZ) for sugar cane in Tamil Nadu are Cuddalore, Erode, Namakkal, Perambalur, Theni and Villupuram districts that have both better area coverage and

Table 3. Efficient sugarcane cropping zone over Andhra Pradesh (2007-08 to 2016-17)

District	Sugarcane Area (ha)	Total sugarcane Production (Tonnes)	Yield (t/ha)	Cultivable area (ha)	% of sugarcane area to total cultivable area	RSI	RYI	Zone classification
East Godavari	14508	1241322	86	690333	2	106	105	MECZ
Krishna	15476	1478842	96	702462	2	111	118	MECZ
West Godavari	27973	2531370	91	694012	4	203	111	MECZ
Chittoor	29945	2581440	86	412178	7	366	105	MECZ
Nellore	6872	664852	97	417772	2	83	118	YECZ
Vizianagaram	14770	878016	60	384740	4	193	74	AECZ
Visakhapatanam	39492	2108756	54	359386	11	553	66	AECZ
Srikakulam	6656	486506	73	433450	2	77	89	IECZ

Andhra Pradesh state Area- 1.03 lakh ha; Production- 73.13 lakh tones; Productivity- 71 t/ha. District where sugarcane area was insignificant (<1% of the cultivable area): Anantapur, Prakasam, Kurnool, Kadapa and Guntur.

more productivity. In some of the districts like Coimbatore, Dindigul, Kanchipuram, Madurai, Pudukkottai, Thanjavur and Thiruvallur exhibits high productivity but the acreage under sugarcane is very less, may be due to a limitation with irrigation water availability and are classified under YECZ. In contrast to this, few other districts viz., Ariyalur, Dharmapuri, Karur, Tiruvannamalai and Vellore has

more area under sugarcane but the productivity is comparatively low, hence classified under AECZ. The districts such as Nagapattinam, Salem, Sivaganga, Tiruchirappalli, Tirunelveli, Tiruppur and Virudhunagar fall under IECZ due to both less spread and low productivity. Other districts such as Tuticorin, Thiruvarur, The Nilgiris, Ramnad, Kanniyakumari and Krishnagiri has an insignificant area under sugarcane (Table 1).

Table 4. Efficient sugarcane cropping zone over Telangana (2007-08 to 2016-17)

District	Sugarcane Area (ha)	Total sugarcane Production (Tonnes)	Yield (t/ha)	Cultivable area (ha)	% of sugarcane area to total cultivable area	RSI	RYI	Zone classification
Khammam	4733	395891	84	419587	1	32	106	YECZ
Nizamabad	15025	1155951	76	355236	4	120	96	AECZ
Medak	26174	2007977	77	529149	5	140	98	AECZ

Telangana state Area- 31000 ha; Production- 25.70 lakh tones; Productivity- 82 t/ha

District where sugarcane area was insignificant (<1% of the cultivable area): Warangal, Adilabad, Magabunagar, Nalgonda, Karimnagar, Rangareddy

Sugarcane cropping Zones of Karnataka

In Karnataka, the area under sugarcane cultivation was 4.40 lakh hectares with a production of 33.44 lakh tonnes and productivity of 76 t/ha. Out of 32 districts, sugarcane is cultivated only in 12 districts. Maximum cane was cultivated in five districts of Karnataka viz., Belgaum (143094

tonnes sugarcane production, more than 70 % was contributed from three states viz., Belgaum (40%), Bagalkot (21%) and Mandya (10%) districts. The productivity was the highest in Mandya district (119 t/ha) followed by Davangere and Shimoga (110 t/ha) and Mysore (105 t/ha). Among the 12 districts in Karnataka, the RSI was more in Belgaum, Bagalkot, Mandya, Bidar, Chamarajanagar and Bijapur districts, whereas the yield efficiency was higher in Mandya, Davangere, Shimoga, Mysore, Bagalkot and Chamarajanagar districts. As per the RSI and RYI parameters, Bagalkot, Chamarajanagar and Mandya fell under the MECZ. Districts viz., Davangere, Mysore and Shimoga were categorized under YECZ. Bijapur, Bidar and Belgaum districts were classified as AECZ. As both RSI and RYI were low, Haveri, Gulbarga and Uttar kannad districts were classified under IECZ (Table 2).

Sugarcane cropping Zones of Andhra Pradesh

Andhra Pradesh had 1.03 lakh hectares of sugarcane cultivation area. Total sugarcane production in Andhra Pradesh state was 73.13 lakh tonnes. Of this Chittoor, West Godavari, Visakhapatnam, Krishna and East Godavari districts contribute 22, 21, 18, 12 and 10 per cent respectively to the total sugarcane production totaling to 83 per cent. Average sugarcane productivity was 80 t/ha in Andhra Pradesh. Districts such as Nellore, Krishna, West Godavari, Chittoor and East Godavari registers more than state average productivity. RSI was more in Visakhapatnam, Chittoor, West Godavari, Vizianagaram, Krishna and East Godavari with the appreciable area under sugarcane. As far as the RYI is concerned, Nellore, Krishna, West Godavari, Chittoor and East Godavari had more productivity compared to other districts. Based on the comparative analysis of RSI and RYI, East

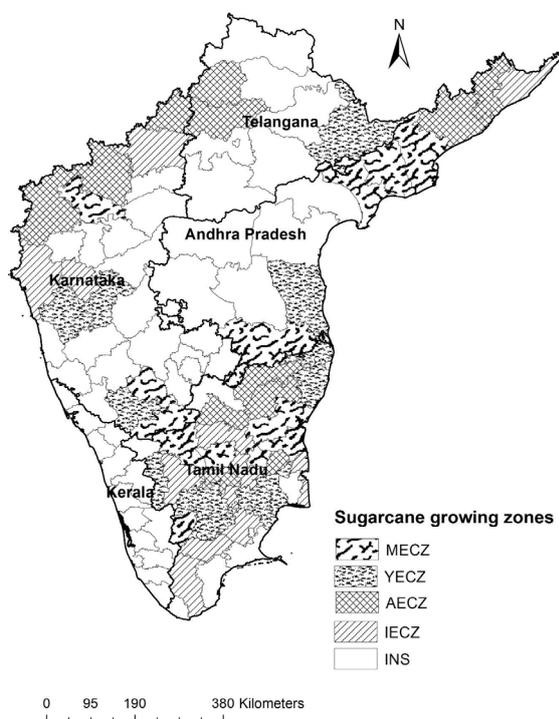


Figure 1. Sugarcane growing zones in southern Indian states

ha), Bagalkot (66743 ha), Bijapur (29609 ha), Bidar (26585 ha) and Mandya (24858 ha). Out of the Karnataka's total production of 30.65 million

Godavari, Krishna, West Godavari and Chittoor are classified under MECZ. Nellore fell under YECZ and Vizianagaram and Visakhapatnam were classified under AECZ. Srikakulam fell under IECZ (Table 3).

Sugarcane cropping Zones of Telangana

Telangana had only 31000 ha of sugarcane area with a total production of 25.70 lakh tonnes of cane. Major districts that cultivate sugarcane were Medak, Nizamabad and Khammam. The average productivity of the state was 79 t/ha and maximum productivity was recorded in Khammam district and classified under YECZ. The two districts viz., Medak and Nizamabad fell under AECZ. The rest of the district was not having an appreciable area under sugarcane in Telangana district (Table 4).

CONCLUSION

Delineation of efficient cropping zone for sugarcane indicated that there is lot of possibility to increase the total production under sugarcane in all the five states of southern India. In the case of AECZ, popularization of high yielding cultivars, improved management technologies such as Sustainable Sugarcane Initiative (SSI) and integrated nutrient management need to be undertaken to improve the yield levels and bring this zone to MECZ. As far as YECZ are concerned, these locations have potential for sugarcane cultivation, however the less spread of area may be due to reduction in water availability. In these regions, micro irrigation with nutrient management such as fertigation need to be popularized. Measured should also be taken to harvest the water and to increase water use efficiency for increasing the area under sugarcane. In the case of inefficient zones, alternate crops may be identified for increasing the farm productivity and farm income.

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