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Identification of efficient cropping zone for major field crops in 27 districts of Chhattisgarh

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Abstract
A study was carried out to identify the efficient cropping zones of major field crops in 27 districts of Chhattisgarh. The data with reference to the area, production and productivity of the major field crops (Rice, Maize, Pigeon Pea, Wheat and Chickpea) for 8 years (2011-12 to 2018-19) were collected from the directorate of economics and statistics, Government of Chhattisgarh. Two indices viz Relative Spread Index (RSI) and Relative Yield Index (RYI) were computed and the potential cropping districts for the study crops were identified. In Chhattisgarh, out of 27 districts 4, 7, 4, 5 and 2 districts were found as a MECZ for Rice, Maize, Pigeon Pea, Wheat and Chick Pea, respectively. Similarly among 27 districts of the state 4, 3, 11 and 13-13 districts are fall under ECZ for Rice, Maize, Pigeon Pea and Wheat, Chick Pea, respectively. In Chhattisgarh, out of 27 districts 5-5 and 3-3 districts were found as a LECZ for Rice, Maize, Wheat and Pigeon Pea, Chick Pea, respectively. Similarly among 27 districts of the state 15, 12, 4 and 9-9 districts are fall under NECZ for Rice, Maize, Wheat and Pigeon Pea, Chick Pea, respectively.

Keywords: efficient cropping zones, RSI, RYI, MECZ, ECZ, NECZ and LECZ

Introduction
The gross cultivated area of Chhattisgarh is 5.6 m ha and 4.7 million hectares area is under cultivation in rainy season. Major field crops grown during kharif and rabi season in the state rice (4141378 ha), maize (118047 ha), pigeon pea (62420 ha), wheat (99925 ha) and chickpea (330912 ha). The production and productivity of these crops are good across 27 districts of Chhattisgarh (Directorate of economics and statistics, Government of Chhattisgarh, 2018-19). Definition of Efficient Cropping Zones (ECZ) is a methodology through which we can identify the potential area of the crop with the help of calculated Relative Yield Index (RYI) and Relative Spread Index (RSI) which in turn efficient cropping zone of the crops (Veeraputhiran and Kathikeyan 2003) [9]. In crop production, an efficient zone is an area which has suitable soil and climate to obtain the maximum productivity of a crop (Narayanan *et al.* 2003) [4]. The productivity level of each and every crop is varying from place to place and therefore identification of efficient cropping zone will be helpful to prepare a strategic plan for optimum use of available resource. On the basis of outcome of this study, we can identified the area suitable for particular crops, if a crops not falls an efficient cropping zone then that crop can be replaced by the other suitable crops which have good potential to achieve optimum yield (Thavaprakaash *et al.* 2008) [8].

Material and Method
The data related to area, production and productivity and total cultivable area of Rice, Maize, Pigeaonpea, Wheat and Chickpea crops in 27 districts of Chhattisgarh were collected for 2011–12 to 2018– 2019 (08 years) from the directorate of economics and statistics, Government of Chhattisgarh.
The formula given by Kanwar (1972) [1] was used to find out Relative Spread Index (RSI) and Relative Yield Index (RYI) for each crop to identify efficient crop zone for the major crops in 27 districts of Chhattisgarh. The details are given here under

$$\text{RSI} = \frac{\text{Area of particular crop expressed as percent of total cultivable area in the district}}{\text{Area of crop expressed as percentage to the total cultivable area in the state}} \times 100$$

Where in RSI: Relative Spread Index

$$RYI = \frac{\text{Mean yield of a particular crop in a district (Kg/ha)}}{\text{Mean yield of the crop in the state (Kg/ha)}} \times 100$$

Where in RYI: Relative Yield Index

Table 1: Criteria for efficient cropping zone

RSI	RYI	Combination of RSI and RYI	Cropping Zone
>100 (High)	>100 (High)	High+ High	Most Efficient Cropping Zone (MECZ).
< 100 (Low)	>100 (High)	Low+ High	Efficient Cropping Zone (ECZ).
> 100 (High)	<100 (Low)	High+ Low	Less Efficient Cropping Zone (LECZ).
< 100 (Low)	< 100 (Low)	Low+ Low	Not Efficient Cropping Zone (NECZ).

Result And Discusion

Efficient Cropping Zone for Rice

The perusal of table 2 and 3, where data of area and productivity of rice crop grown in 27 districts of Chhattisgarh, revealed that the Janjgir-champa, Dhamtari, Raipur and Bilaspur reported, high RSI and RYI falls under most efficient cropping zone (MECZ) for cultivation of rice followed by Mungeli, Durg, Kanker and Sukma which falls under Efficient Cropping Zone (ECZ) with low RSI and high RYI values. The districts Bijapur, Mahasamiund, Gariaband, Baloda Bazar and Raigarh observed Less Efficient Cropping Zone (LECZ) where high RSI and low RYI values were observed. 15 districts fall under Not Efficient Cropping Zone (NECZ) where both RSI and RYI values were below 100 per cent.

Sanbagavalli *et al.* (2002) [6] also observed that among the 2 districts of Tamil Nadu, Tirunelveli and Kanyakumari were the most efficient cropping zones (MECZS) for rice cultivation. Similar results was also reported by Kokilavani and Geethalakshmi (2013) [2] they found that, 9 districts of Tamil Nadu were found to be prospective regions for rice cultivation, 7 districts for cultivation of maize and 3 districts for groundnut cultivation as in these areas both the RSI and the RYI were high.

Efficient Cropping Zone for Maize

Maize crop is sensitive to both excessive moisture and moisture stress situation and optimum amount of water is needed throughout the crop growth period. The table 2 and 3 indicates that the MECZ which has high RSI and RYI for maize crop was found in Balrampur, Bastar, Dantewada, Kanker, Kondagaon, Narayanpura and Sukma in Chhattisgarh. The districts such as Dhamtari, Janjgir-Champa and Raigarh fall under ECZ with low RSI and high RYI values. The districts Gariaband, Korba, Korea, Surguja and Surajpur observed LECZ where high RSI and low RYI values were observed. 12 districts fall under NECZ where RSI and RYI values both were found below 100 per cent.

Sanbagavalli et al. (2020) [7] also observed that among 32 districts of Tamil Nadu, 5 districts viz Ariyalur, Coimbatore, Erode, Theni and Tiruppur were found under most efficient cropping zone (MECZ) for cultivating the maize crop. This is in agreements with the finding of Kokilavani and Dheebakaran (2019) [3] that 7 districts were found prospective regions for rice and 4 districts of Tamil Nadu for maize cultivation as in these areas both the RSI and the RYI were more than 100 per cent.

Efficient Cropping Zone for Pigeon Pea

It is a made clean from table 2 & 3 in Chhattisgarh, the MECZ which has high RSI and RYI for Pigeon Pea was found in districts Balrampur, Jashpur, Sarguja and Surajpur. Whereas districts like Bastar, Bijapur, Bilaspur, Dantewada, Durg, Janjgir-Champa, Kondagaon, Mungeli, Narayanpur, Sukma and Raigarh categorized under ECZ with low RSI and high RYI values which indicate that here efforts should be made to increase the area of Pigeon pea crop. The districts Kabirdham, Koria and Rajnandgaon belong to LECZ which reported high RSI and low RYI values. Rest 9 districts reported RSI & RYI value below 100 percent considered under NECZ.

Pavithra et al. (2020) [5] also observed that among the different districts in Tamil Nadu, Selam, Theni, Namakkal, Madurai, Vellore, Thiruvannamalai and Dharmapuri were found most efficient cropping zone for cultivation of red gram.

Efficient Cropping Zone for Wheat

The perusal of table 2 and 3 where data of area and productivity of Wheat crop was presented revealed that the Balrampur, Bilaspur, Mungeli, Surguja and Surajpur reported high RSI and RYI falls under most efficient cropping zone MECZ for cultivation of Wheat crop followed by Bastar, Baloda Bazar, Dhamtari, Dantewada, Gariaband, Janjgir-Champa, Jashpur, Kanker, Narayanpur, Kondagaon, Mahasamund, Raipur and Raigarh, which considered under ECZ with low RSI and high RYI values. The districts Bemetara, Durg, Kabirdham, Koria and Rajnandgaon were categorized under LECZ where high RSI and low RYI values were reported. RSI & RYI value in 4 districts were below 100 per cent falls under NECZ.

Efficient Cropping Zone for Chick Pea

A close observation of table 2 & 3 indicates that districts Bemetara and Mungeli belong to MECZ where high RSI and RYI value reported. Districts like Balod, Bastar, Baloda Bazar, Bilaspur, Dhamtari, Gariaband, Janjgir-Champa, Jashpur, Kanker, Kondagaon, Mahasamund, Raipur and Raigarh categorize falls under ECZ with low RSI and high RYI values which indicate that these areas are having high yield but its coverage is less, so in their districts area can be increased. Districts Durg, Kabirdham and Rajnandgaon considered under LECZ where a high RSI and low RYI value was reported. The RSI and RYI values were below 100 per cent were 9 districts falls under NECZ.

Table 2: Computed value of RSI and RYI for major field crops in 27 districts of Chhattisgarh (average of 8 years)

S. No.	Districts Name	Rice		Maize		Pigeon PEA		Wheat		CifiCK PEA	
		RSI	RYI	RSI	RYI	RSI	RYI	RSI	RYI	RSI	RYI
1	Balod	91.4	99.9	3.6	69.1	17.4	90.5	68.7	72.6	68.5	112.9
2	Baloda Bazar	103.0	85.2	1.6	74.3	35.5	64.1	82.6	128.9	18.4	114.3
3	Balrampur	57.2	92.7	483.1	102.0	400.9	107.1	282.3	117.6	10.8	93.7
4	Bastar	93.3	88.3	217.5	122.3	20.7	115.6	10.7	154.8	3.0	108.7
5	Bemetara	58.7	89.3	0.4	64.1	91.9	96.1	232.1	74.0	498.6	108.1
6	Bijapur	117.6	88.2	39.2	96.1	0.9	134.3	NA	NA	NA	NA
7	Bilaspur	100.4	104.2	43.6	87.7	61.6	104.8	139.7	106.9	17.2	102.0
8	Dantewada	85.7	84.3	127.4	103.4	30.0	127.1	0.3	128.2	0.3	76.0
9	Dhamtari	102.1	146.1	43.8	133.3	7.6	71.2	39.2	109.2	86.7	116.6
10	Durg	86.5	114.1	6.4	71.0	55.2	100.7	189.2	83.4	161.6	98.8
11	Gariyaband	108.6	86.5	164.0	78.2	28.7	64.7	13.1	122.9	6.4	109.5
12	Janjgir-Champa	113.3	164.6	4.8	102.7	27.8	107.3	36.3	125.6	1.2	107.4
13	Jashpur	88.7	73.9	90.9	94.7	153.1	102.9	26.7	107.8	7.6	102.2
14	Kabirdham	50.1	73.8	37.3	74.3	206.0	90.5	179.4	86.1	581.1	86.1
15	Kanker	96.0	111.3	186.9	109.9	17.3	95.7	10.1	131.1	5.2	103.5
16	Kondagaon	91.2	86.0	426.1	114.5	9.7	103.3	5.9	143.8	5.2	113.5
17	Korba	98.7	78.0	130.6	80.2	81.5	97.6	22.6	79.7	4.0	80.1
18	Korea	77.2	83.6	292.7	86.8	282.3	93.2	181.7	91.6	7.8	71.9
19	Mahasamund	114.2	93.4	1.6	78.2	17.9	66.4	22.1	125.4	1.1	101.9
20	Mungeli	66.8	116.2	3.1	80.0	72.9	105.4	145.8	102.2	144.1	104.8
21	Narayanpur	93.4	73.6	143.4	111.8	23.5	116.5	2.6	149.4	2.6	98.2
22	Raigarh	100.8	91.5	12.9	100.6	70.5	111.0	55.1	157.4	3.1	109.6
23	Raipur	104.3	117.2	7.1	80.4	20.0	74.5	85.3	132.3	40.0	115.3
24	Rajnandgaon	76.4	84.8	36.0	79.0	169.7	97.5	169.7	87.5	252.1	96.1
25	Surajpur	76.5	88.2	248.1	91.5	196.0	100.6	187.7	107.3	9.2	86.4
26	Sukma	95.8	100.0	112.4	114.5	34.5	102.9	0.1	80.9	0.0	50.4
27	Surguja	80.9	89.9	211.4	93.1	191.5	107.5	160.4	107.4	15.0	91.1

*NA- Data not available

Table 3: Classification of Efficient cropping zone for major field crops in 27 districts of Chhattisgarh (average of 8 years)

S. No.	Districts Name	RICE			Maize			Pigeon PEA			Wheat			CifiCK PEA		
		RSI	RYI	Cropping Zone	RSI	RYI	Cropping Zone	RSI	RYI	Cropping Zone	RSI	RYI	Cropping Zone	RSI Sign	RYI Sign	Cropping Zone
1	Balod	L	L	NECZ	L	L	NECZ	L	L	NECZ	L	L	NECZ	L	H	ECZ
2	Baloda Bazar	H	L	LECZ	L	L	NECZ	L	L	NECZ	L	H	ECZ	L	H	ECZ
3	Balrampur	L	L	4ECZ	H	H	MECZ	H	H	MECZ	H	H	MECZ	L	L	4ECZ
4	Bastar	L	L	NECZ	H	H	MECZ	L	H	ECZ	L	H	ECZ	L	H	ECZ
5	Bemetara	L	L	NECZ	L	L	NECZ	L	L	NECZ	H	L	LECZ	H	H	MECZ
6	Bijapur	H	L	LECZ	L	L	NECZ	L	H	ECZ	NA	NA	NA	NA	NA	NA
7	Bilaspur	H	H	MECZ	L	L	NECZ	L	H	ECZ	H	H	MECZ	L	H	ECZ
8	Dani'ewada	L	L	NECZ	H	H	MECZ	L	H	ECZ	L	H	ECZ	L	L	NECZ
9	Dhamtari	H	H	MECZ	L	H	ECZ	L	L	NECZ	L	H	ECZ	L	H	ECZ
10	Durg	L	H	ECZ	L	L	NECZ	L	H	ECZ	H	L	LECZ	H	L	LECZ
11	Gariyaband	H	L	LECZ	H	L	LECZ	L	L	NECZ	L	H	ECZ	L	H	ECZ
12	Janjgir-Champa	H	H	MECZ	L	H	ECZ	L	H	ECZ	L	H	ECZ	L	H	ECZ
13	Jashpur	L	L	NECZ	L	L	NECZ	H	H	MECZ	L	H	ECZ	L	H	ECZ
14	Kabirdham	L	L	NECZ	L	L	NECZ	H	L	LECZ	H	L	LECZ	H	L	LECZ
15	Kanker	L	H	ECZ	H	H	MECZ	L	L	NECZ	L	H	ECZ	L	H	ECZ
16	Kondagaon	L	L	4ECZ	H	H	MECZ	L	H	ECZ	L	H	ECZ	L	H	ECZ
17	Korba	L	L	NECZ	H	L	LECZ	L	L	NECZ	L	L	NECZ	L	L	NECZ
18	Korea	L	L	NECZ	H	L	LECZ	H	L	LECZ	H	L	LECZ	L	L	NECZ
19	Mahasamu1d	H	L	LECZ	L	L	NECZ	L	L	NECZ	L	H	ECZ	L	H	ECZ
20	Mungeu	L	H	ECZ	L	L	NECZ	L	H	ECZ	H	H	MECZ	H	H	MECZ
21	Narayanpur	L	L	4ECZ	H	H	MECZ	L	H	ECZ	L	H	ECZ	L	L	4ECZ
22	Raigarh	H	L	LECZ	L	H	ECZ	L	H	ECZ	L	H	ECZ	L	H	ECZ
23	Raipur	H	H	MECZ	L	L	NECZ	L	L	NECZ	L	H	ECZ	L	H	ECZ
24	Rajnandgaon	L	L	4ECZ	L	L	NECZ	H	L	LECZ	H	L	LECZ	H	L	LECZ
25	Sukma	L	H	ECZ	H	H	MECZ	L	H	ECZ	L	L	NECZ	L	L	NECZ
26	Surajpur	L	L	NECZ	H	L	LECZ	H	H	MECZ	H	H	MECZ	L	L	NECZ
27	Surguja	L	L	4ECZ	H	L	LECZ	H	H	MECZ	H	H	MECZ	L	L	4ECZ

*L-Low, H-High

Conclusion

On the basis of concept of efficient cropping zone, the district Balrampur was considered as most efficient cropping zone (MECZ) for growing Maize, Pigeon Pea and Wheat crops whereas districts Bilaspur, Dhamtari, Janjgir-Champa and Raipur were found as MECZ for cultivation of Rice crop. Only 2 districts i.e. Bemetara and Mungeli were considered as MECZ for cultivation of Chickpea crop. Districts Raigarh and Janjgir-Champa were fall under efficient cropping zone (ECZ) for cultivation of Maize, Pigeon Pea, Wheat and Chick Pea crops. In order to bring all ECZ areas under MECZ for these crops, improved varieties, advanced cultural practices, better management practices and availability of need based quality inputs at reasonable price must be made available to the farming community of the districts in time. In order to popularize these crops in the LECZ and NECZ, farmers are to be trained in innovative technologies to explore higher productivity, which can be done by strengthening the extension services.

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