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Identifying hotspots of coconut cultivation in Tamil Nadu

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Abstract
Coconut (*Cocos nucifera L*) is multi-utility horticultural crop both in food and cosmetic industries. The natural oil from coconut competes with other low valuable vegetable oils in the international market due to consequence of globalization and erratic weather. Among the Indian states, viz, Kerala, Karnataka, Tamil Nadu and Andhra Pradesh are contributing 90 per cent of the total production. Tamil Nadu is leading in productivity and stood 2nd place in cultivated area among India. In this study, trend analysis on area, production and productivity for 30 year (1985-2015) was done and it was further extended in delineating Efficient Cropping Zones (ECZ) of coconut among the districts of Tamil Nadu during 2001-2015. Relative Yield Index (RYI) and Relative Spread Index (RSI) were used to identify the potential cropping districts. Result revealed that trends in area, production and productivity showed an increasing drift with over the years. Even though, production and productivity of coconut showed fluctuations during the mid-period of study, overall growth rate of 35.0 per cent, 29.2 percent, 42.0 percent was observed in coconut area, production and productivity for entire state. Identification of hotspot areas revealed that Coimbatore, Tirupur, Vellore, Thanjavur, Madurai, Theni, Dindigul, Tirunelveli, Kanniyakumari, Krishnagiri, Dharmapuri, Salem, Viruthunagar and Sivagangai districts found to be most efficient cropping zones for cultivation. Findings inferred that the increasing trend of coconut area, production and productivity has brought new challenges for marketing and transporting. Hence, this study helps government and policy makers to create an opportunity regarding coconut-based marketing at efficient places.

Keywords: coconut, relative spread index (RSI), relative yield index (RYI), efficient cropping zones

1. Introduction
Indian agriculture sustains as the backbone of the country's economy. The diversification and shrinking natural resources changed the cultivation aspects, which has forced the farming community and policy makers to explore an alternate from traditional farming that has more remunerative and sustainable production portfolio. Shifting of cultivation over the years makes farmers to move towards non-food grain and high value commodities which generates the potential income, employment opportunity, poverty alleviation and export promotion. Crops with more value are being considered by farmers and there is also an emerging interest towards value added products. In this aspect, coconut cultivation can profound the rural economy, afford food security and livelihood to a large size of population around the world.

Coconut also called as "Tree of Life" is inseparably embedded in the social heritage as well as the cultural identity being eulogized as "Kalpavriksha (Tree of Heaven)". It is a versatile crop and a tree which provides all the necessities of life, hence, being cultivated in more than 90 countries globally. Though, coconut cultivation plays a vital role in boosting Indian economy, 98 per cent of the small and marginal farmers are holding cultivable land less than two hectares (Singh, 2010) [8]. According to Union Ministry for Agriculture and Farmers Welfare, India is a prominent contributor in the global coconut production and productivity, which is 2,395 crore nuts on annual coconut production from 20.82 lakh hectare area and a productivity of 11,505 coconuts/hectare is obtained. Economic contribution to Indian Gross Domestic Product (GDP) from coconut is about Rs. 27,900 crores which is 72 per cent of world's total production and it is estimated that around 12 million people in our country depend on coconut sector, which would be coupled with various bountiful monsoon in all over India (Statista, 2020) [11].

Out of total coconut production in our country, around 50 per cent, 35 per cent and 15 per cent is used as mature nuts, copra and tender drink respectively. Precisely, 92 per cent of the mature raw nuts are consumed domestically while sparse 8 per cent is involved into value-added products by the industries, specifically milling type of copra is produced mainly from Kerala and Tamil Nadu state which is accounting for 90 per cent of total domestic production (CACP, 2015). Demand of activated charcoal from Indian coconut shell is expanding globally in the recent decades not only for its superior quality in terms of adsorption of gas or vapour also for involving mitigation of environmental pollution, particularly to remove heavy metal residues in industrial pollutants. Available activated carbon in global market was estimated to be 1.25 million tons (10% global demand of activated carbon from coconut shell) in 2012 and the demand will be expected to increase at a rate of 11.7 per cent at end of the decade (Cobb *et al*., 2012) [2].

Oil content of coconut copra varies from 60 to 65 per cent and 92 per cent of saturated fatty acid. Oil production observed in India is nearly 5.5 lakh tonnes in 2014-2015, of which 40 per cent, 46 per cent and 14 per cent are consumed for edible purposes, toiletry use and industrial purposes respectively, which meets the 20 per cent and 6 per cent of the global market demand and national demand for total oils and fats requirements respectively

(Krishna *et al.*, 2010). Coconut Coir (dry husk) fibre is highly resistance to salt water, hence, used mostly to reclamation of salt affected soils as well as coir-based industries are manufacturing ropes, baskets, mats, brushes and brooms. An average utilization of coir fibre in India is around 28.41 per cent and has potential to generate economic value of around Rs. 3,135.54 to Rs. 4,221.44 crores per annum (Coir Board, 2014). The national production was recorded as 3,23,900 MT Coir Yarn in 2013-14 while it was 3,21,701MT and 3,18,900 MT in 2012-13 and 2010-11 years respectively, which clearly explained that production of coconut and based products were in an increasing trend over the years. Among the states of India, Tamil Nadu tops in coir yarn production followed by Kerala, Andhra Pradesh, Karnataka, Odisha and others (Coir Board, 2016). Thus, coconut becomes a wonder crop with economic benefits from all its parts.

Efficient Cropping Zone analysis for Coconut crop would help the researchers, stakeholders and policy makers to focus on developmental activities. This research paper aims on this aspect to identify the ECZs available in Tamilnadu state on district scale for a period between 2001 and 2015.

2. Methodology

2.1 Data

The study was carried out over Tamilnadu, India. District level data on area, production and productivity of Coconut were collected for 30 years (1985-2015) to examine trend changes in coconut cultivation. Also, total cultivable area of Tamil Nadu was collected for 15 years (2000-2015) to identify the Efficient Cropping Zone (ECZ) of coconut over Tamil Nadu. The data were collected from crop production statistics information system and respective season and crop reports (SCR).

2.2 Trend analysis

The trend analysis of area, production and productivity were plotted, and the trend line was obtained as the following equation

$$\mathbf{Y_t = abt\ e^{ut}}$$

Where,

Y_t = Dependent variable in period t (Area/ Production/ Productivity)

a = Intercept

b = Regression coefficient= (1+g)

t = Years which takes values, 1, 2, n

ut = Disturbance term for the year t

2.3 Efficient Cropping Zone

RSI and RYI were calculated for delineating the efficient cropping zone for coconut cultivation in Tamil Nadu during 2001 to 2015 study period. For better understanding of shift in coconut cultivation, the study period was grouped into three time periods viz., 2001-2005, 2006-2010 and 2011-2015 with a comparative base period (1995-2000). Statistical computation formulae used in this study to calculate Relative Yield Index (RYI) and Relative Spread Index (RSI) and criteria for classification of Efficient Cropping Zone (EFC) are given as follows (Pradipa *et al.*, 2018 and Sankar *et al.*, 2019),

$$RSI = \frac{\text{Area of particular crop expressed as \% of total cultivable area in the district}}{\text{Area of crop expressed as percentage to the total cultivable area in the State}} * 100$$

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

Table 1: Criteria for classification of ECZ

RSI	RYI	Cropping Zone
>100 (High)	>100 (High)	Most Efficient Cropping Zone (MECZ)
>100 (High)	< 100 (Low)	Efficient Cropping Zone (ECZ)
< 100 (Low)	>100 (High)	Not Efficient Cropping Zone (NECZ)
< 100 (Low)	< 100 (Low)	Highly Inefficient Cropping Zone (HICZ)

2.4 Mapping

ArcGIS v10.5 was used to map the district level Efficient Cropping Zones of coconut crop over Tamilnadu state. The maps were created for the 5 years average time periods and compared with the base period (1995-2000) to understand the shift of cropping zones. An average map for the 15 years study period (2001-2015) was also created.

3. Results

3.1 Trend Analysis

Trend analysis in coconut area, production and productivity over Tamil Nadu was conducted during 1985-2015 for various districts. Result of this research provided a piece of knowledge that there was an increasing trend in coconut cultivable area, production and productivity over the years. The highest rate of increase in area was observed during 2013-2014 which was 4.28 lakh ha. It is observed that there was an enormous increase in cultivated area of coconut after 2000-2001 and continues till the end of study period, which was 1.49 lakh ha to 4.27 lakh ha from 1985 to 2015 respectively (Figure 1).

As per production concern, it also showed an increasing trend over the years. The production was very minimum during the early period of study till 1997-1998 and continuously showing a decreasing trend until 2003-2004, rather steadily increasing in the later years, which was 14584 lakh nuts to 49865 lakh nuts from 1985 to 2015 respectively. Identically, coconut productivity had followed the same trend as production and has no continuous increasing trend, fluctuating till 2003-2004 and after which the productivity increased till 2011-2012 in Tamilnadu. Due to climatic shift and frequent extreme weather events, productivity of coconut showed a decreasing trend after 2011-2012. An average productivity of coconut nuts increased from 1.39 lakh nuts during 1985 to 3.32 lakh nuts during 2015. An overall growth rate of 35 per cent, 29.2 per cent, 42 per cent was observed in coconut area, production and productivity respectively, over Tamilnadu state (Figure 1).

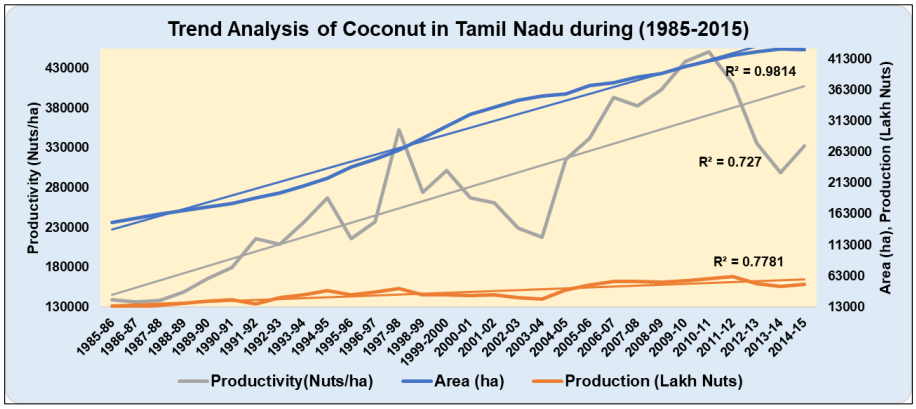

Fig 1: Trend of Area, Production and Productivity of Coconut in Tamilnadu during (1985-2015)

The production analysis (Figure 2) revealed that 25-50 per cent of the years have resulted in 26,169 – 33,062 lakh nuts, while 51 – 75 per cent of the years have produced 33,062 – 49,567 lakh nuts on the state total. The highest value of production attained was 62,009 lakh nuts (2011-2012) and the lowest was 13,281 lakh nuts (1986-1987).

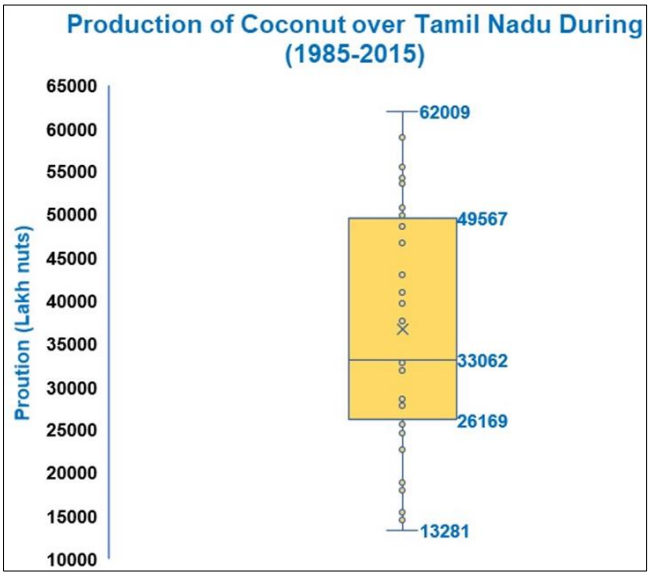

Fig 2: Production of Coconut over Tamilnadu (1985-2015)

3.2 Efficient Cropping Zone (ECZ)

Sustainability in crop production can be achieved when the crops are being cultivated at efficient locations. ECZ is identified by using RYI and RSI where, RSI is determined by inputs such as seeds, fertilizers, water, pesticides, availability of labour, technology, Government policies *etc.*, whereas, RYI is determined by the climate of a particular domain along with prevailing weather within that climate (Kanwar, 1972). Hence, a portion of present study focuses on delineating the efficient cropping zones for coconut cultivation in Tamil Nadu during a study period of 15 years (2001-2015).

The base period (1995-2000) study of coconut crop reveals it is Most Efficiently cropped in Kanniyakumari, Tirunelveli, Theni, Thiruvarur, Thanjavur, Coimbatore and Vellore districts, while Karur and Dindigul districts have been ECZs (Figure 3a). The districts such as Coimbatore, Vellore, Thanjavur, Madurai, Theni, Dindigul, Tirunelveli and Kanniyakumari were found to be the efficient cropping zone for coconut cultivation in Tamil Nadu during 2000-2005 study period (Figure 3b). Over the years, importance of coconut production was well cognizant by farmers and cultivation spread out to districts such as Krishnagiri, Dharmapuri and Salem districts along with earlier other districts during 2006-2010 study period (Figure 3c). During 2011-2015, it is observed that the cultivation has expanded out to districts such as Krishnagiri, Tirupur, Viruthunagar and Sivagangai along with earlier efficient districts (Figure 3d). In the entire study period (2001-2015) of Coconut crop - Kanniyakumari, Madurai, Theni, Dindigul, Thiruvarur, Krishnagiri districts were found to be Most Efficient Cropping Zones (MECZs) while Coimbatore, Vellore, Tiruppur and Tirunelveli identified as Efficient Cropping Zone (Figure 3e).

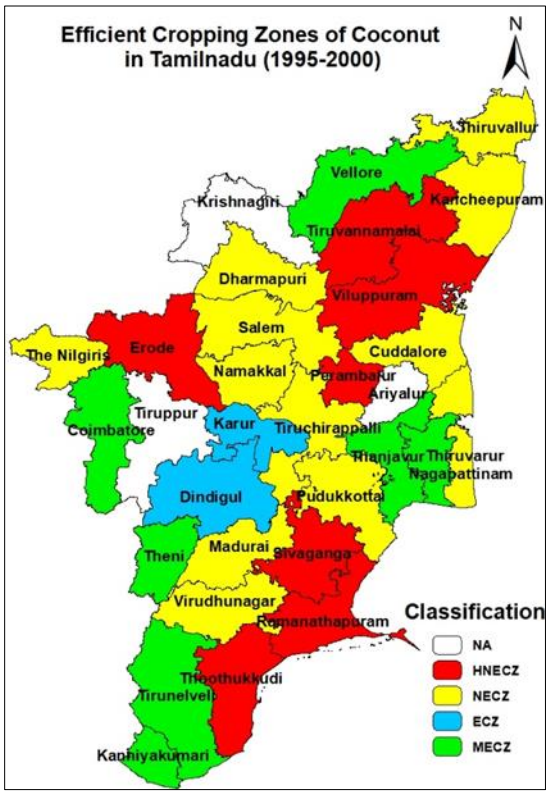

Fig 3a: Efficient Cropping Zones of Coconut in Tamilnadu (1995-2000)

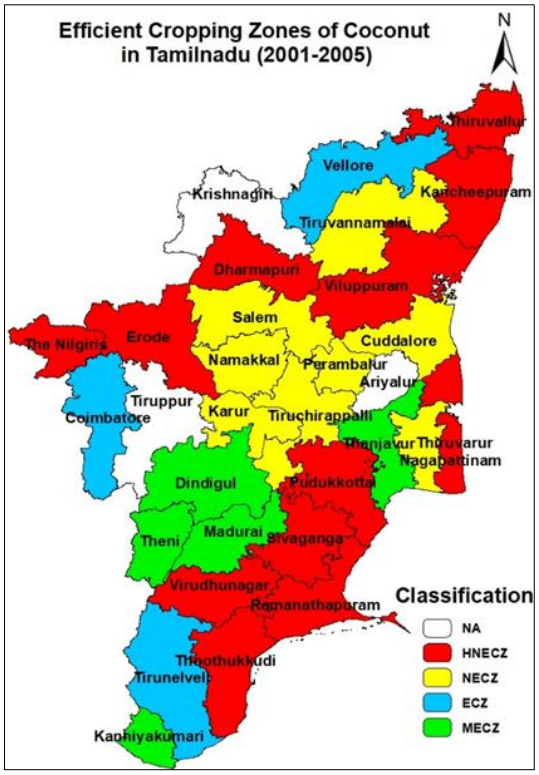

Fig 3b: Efficient Cropping Zones of Coconut in Tamilnadu (2001-2005)

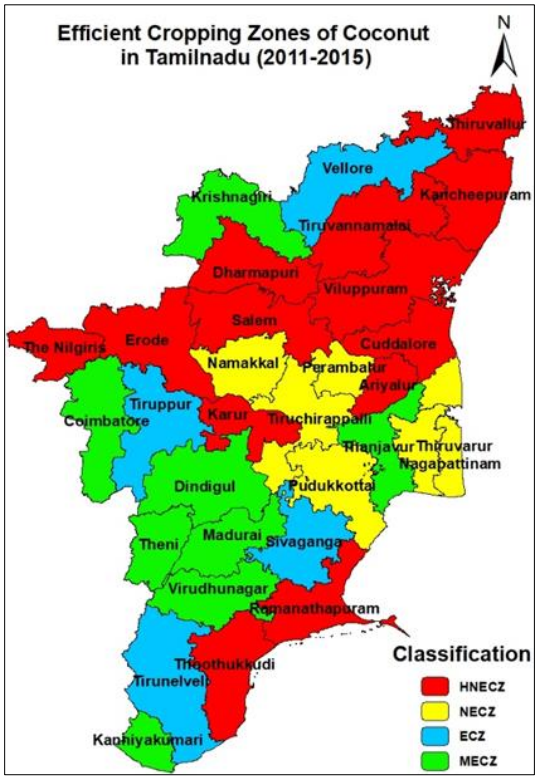

Fig 3d: Efficient Cropping Zones of Coconut in Tamilnadu (2011-2015)

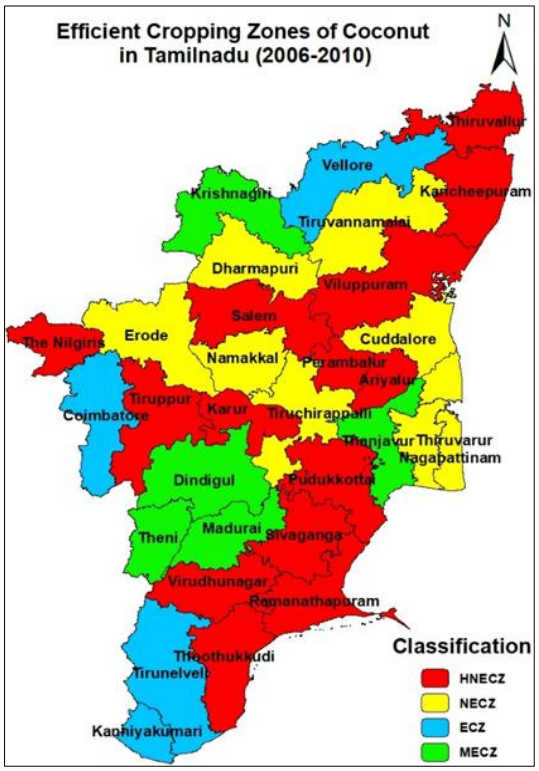

Fig 3c: Efficient Cropping Zones of Coconut in Tamilnadu (2006-2010)

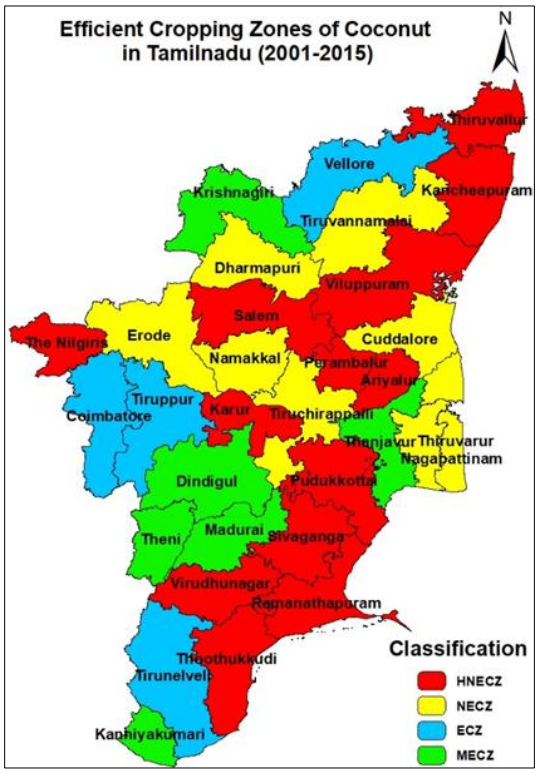

Fig 3e: Efficient Cropping Zones of Coconut in Tamilnadu (2001-2015)

4. Discussion

Efficient Cropping Zone delineation for coconut crop over Tamilnadu was done for the study period of 15 years (2001-2015) after confirming an increasing trend of area, production and productivity. Trend analysis was supported by Gigi Elias, 2015 who indicated that an increasing trend was observed in total area of coconut cultivation at Karnataka and Tamil Nadu States among India over the years. Also, the trend was supported by the study of Preethi *et al.* (2019) [9] that area, production and productivity growth rate of coconut in India showed a significant and positive growth in area (1.92 per cent), production (3.77 per cent) and productivity (1.92 per cent) respectively. Vethamuthu (2015) [12] found that overall growth trend of coconut in Indian cultivable area, production and productivity were 1.87 per cent, 2.98 per cent and 1.09 per cent respectively during the study period between 1950 and 2016.

In a view of efficient areas, Kannan *et al.* (2017) [7] found the same result that Coimbatore district is having largest coconut cultivated area among other districts of Tamil Nadu, followed by Tiruppur, Thanjavur and Dindigul. In terms of percentage of coconut cultivated area Tiruppur stands first, followed by Kanyakumari, Coimbatore and Thanjavur. Though Coimbatore is regarded as the coconut zone of Tamilnadu, it is in the slow pace of losing the position which was confirmed by the studies of Yamuna and Ramya (2016) [13] and Govindasamy (2018) [6] which is a serious concern. Thus, the changes in MECZs and ECZs have to be taken into account for developing sustainable measures by the policy makers.

5. Conclusion

Analysis on Efficient Cropping Zones of Coconut was able to identify the existing and emerging hotspots of coconut cultivation. Kanniyakumari, Madurai, Theni, Dindigul, Thiruvarur, Krishnagiri districts had performed as Most Efficient Cropping Zones; Coimbatore, Vellore, Tiruppur and Tirunelveli are Efficient Cropping Zones as identified by the study. The overall trend of area, production and productivity on the state level was found to be increasing, which is a positive feedback.

This study has proven that with the intention of efficiently utilizing the natural resources, farmers are redesigning existing cropping pattern. Therefore, coconut cultivation glimpses up the preferences of small and marginal farming communities with its economical benefits. In case of marketing coconut-based products, market information has to be improved among the government officials, stake holders, policy makers and rural farmers as well. Hence, this present investigation provides a basic knowledge regarding the importance of trend changes and identifies efficient cropping areas of coconut where markets are to be ventured.

6. Acknowledgement

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