Diversification of Agriculture in Coastal Districts of Tamil Nadu– a Spatio- Temporal Analysis

K.Palanisami[1], C.R.Ranganathan[1], S.Senthilnathan[1] and Chieko Umetsu[2]
[1]Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India
[2]Research Institute for Humanity and Nature, Kyoto, Japan.

Abstract

Crop diversification is considered as a resilience mechanism followed by farmers in different regions. Socio-ecological systems of coastal areas are more vulnerable to the impact of climatic changes. In the present paper, it is shown that there exists wide spatio-temporal disparity in the diversification of crops in the coastal districts of Tamil Nadu State, India. This is done by constructing a crop diversification index which provides a basis for ranking the different districts. So in those regions which are more vulnerable for climatic change, more diversification of crops must be attempted to avoid risk of crop failure and loss of income and employment to the rural people.

1. Introduction

Socio-ecological system of coastal areas are usually fragile and sensitive to vagaries of weather. They are more vulnerable to the impact of climatic changes. For such a society faced with diminishing natural resources and every increasing demand for food consumption and food security due to increase in population growth, agricultural intensification including fisheries is the only course of action for future growth of agriculture. Agricultural intensification can be achieved by changes in cropping pattern or crop diversification. It is certainly an important component of the overall strategy for small farm development. It is usually viewed as a risk management strategy. It also provides for self provisioning in the context of non-monetized traditional system. As market opportunities develop and or risks are somehow reduced, the enterprise mix begins to respond to market forces and it was this perspective which was more relevant in the context of altered economic environment. Agricultural diversification really started in the early eighties in India and it has picked up momentum over the recent past and farmers were always quick to diversify into higher value crops as market opportunities developed.

Crop diversification has lot of benefits food & nutrition security, income growth, poverty alleviation, employment generation, judicious use of land and water resources, sustainable agricultural development and environmental improvement. To improve the incomes, to provide gainful employment and to stabilize the income flow, diversification of crops emerges as a major strategy. Besides in several circumstances diversification is needed to restore the degraded natural resource base or to enhance the value of natural resources. In several instances cropping systems have been diversified or new cropping systems have been introduced to retain or to enhance the value of natural resources principally land and water. There is also the claim that diversification tends to stabilise farm income at a higher and higher level. This happens when the pattern of

diversification is such as to accommodate more and more rewarding crops. This is particularly important for the small farmers who strive to make their farms viable (Saleth, 1995).

2. Earlier Studies on Diversification

Saran and Kaur (2002) analyzed the changes in cropping pattern in Punjab during 1970-71 and 1996-97. The study revealed that in almost all the districts in Punjab, specialization was mainly due to agricultural development. Availability of agricultural inputs and institutional factors and infrastructural facilities are essential for attaining most desirable land use patterns best suited to the region. The study indicated that the economic reforms and new international scenario are likely to promise further changes in land use pattern and crop diversification as well.

Shiyani and Pandya (1998) examined the levels of crop diversification in different agro climatic zones over a period o time. The study observed that the farmers have shifted their cropping pattern from the subsistence crops to the commercial crops. On an average, relatively higher growth rates of acreage under tur castor, rapeseed, mustard, sugarcane, maize and wheat were found in different agro climatic zones of Gujarat, whereas negative compound growth rates of acreage under pearl millet, jowar and cotton were noticed in most oft the zones. The study suggested the establishment of agro processing industries and infrastructural facilities, arrangement for crop protection, construction, maintenance and management of irrigation works, research prioritization, distribution of quality seeds and seed materials of the specific crops in the specific zone on the basis of cropping pattern and need of the people of the region.

Ajjan and Selvaraj (1996) analyzed the impact of crop diversification among the small tea growers in the Nilgiris district of Tamil Nadu. The results showed that there had been a major shift in cropping pattern. The area under potato registered negative growth (-8.58 per cent and the area under tea showed positive growth (5.19 per cent). The economics of crop diversification revealed that tea generated a higher rate of return as compared to potato. It was also observed that the land value of tea increased substantially to Rs.1.59 lakh per ha for potato due to diversification. The crop diversification also had a positive effect on soil conservation and ecology.

Lathar *et al.*(1996) examined the prospects of enhancing the income of the marginal and small farmers through diversification of farming in Sonepet district of Haryana for the year 1993-94. The results revealed that the farmers of both the categories were found to be quite close to the optimal plan which was derived by considering the commonly prevalent crop production activities at the existing level of technology. However with the adoption of advanced production technology being followed by the top 10 per cent of the progressive farers for various crops and high value farm products, the return over variable cost increased by 356 and 184 per cent over the base period for marginal and small farms respectively. Similarly, it was also found that the magnitude of gainful employment has also increased by 30 and 71 per cent over the base period in the case of marginal and small farms respectively. The study suggested that for achieving the gains of diversification of farming, there is an urgent need for further strengthening the required infrastructure pertaining to input supply system, marketing system and the existing research and extension programmes to increase the adoption of advanced production technologies.

Sharma *et al*. (1996) examined the growth of production of different crops in Rajasthan and the changes that had taken place in the cropping pattern from 1960-61 to 1993-94. The results showed that there was a major breakthrough in the growth rate of area and oilseeds at 8.45 and 13.2 per cent respectively resulting in high growth of production at 32.42 per cent per annum. Crop wise results revealed the declining share of cereals in gross cropped area was due to declining share of bajra[1], (from 30.2 to 24.5 per cent), jowar[1] (from 7.6 to 4.1 per cent) in kharif[2] and barley (from 3.0 to 1.1 per cent) in the rabi[3] season. The share of wheat crop in the gross cropped area has increased from 7.8 per cent to 10.5 per cent. Thus the cropping pattern had changed in favour of remunerative crops and it had not affected food security adversely as there is enough scope to increase the cropped area.

Saini *et al.* (1996) in their study on the impact of diversification on small farms economy in Kangra district of Himachal Pradesh observed that the diversification of arable farming systems with commercial enterprises such as high yielding milk animals, poultry birds, bee-keeping, floriculture etc. resulted in a marked increase in the farm income from 6 to 138 per cent. Similarly the capital and credit requirement showed an increasing trend with the extent of diversification implying thereby that to diversify the existing farming systems with the most systematically, remunerative and technically feasible enterprises, adequate facilities should be made available by the financial institutions.

Given the importance of crop diversification under the changing scenarios, a study was undertaken to examine the crop diversification in coastal districts of Tamil Nadu over years and to suggest suitable policy options for furthering the diversification towards the sustainability of agriculture in the region.

3. Date Base

The data for the analysis consisted of area under different crops grown at nine coastal districts of Tamil Nadu (see, Figure 1) during 1980-81, 1985-86, 1990-91, 1995-96, 2000-01 and 2005-06. Nine major crops grown in the coastal districts were selected. The details of the coastal districts and the crops selected for the study are given in Table 1.

Table 1. Coastal Districts of Tamil Nadu and Crops Selected for Study

Coastal Districts	Crops selected for the study
Kancheepuram, Cuddalore, Nagapattinam, Thanjavur, Pudukottai, Ramanathapuram, Tirunelveli, Thoothukudi and Kanniyakumari	Paddy, Cholam, Maize, sugarcane, Cotton, Groundnut, Chillies, Banana and Total pulses

[1] A millet crop largely grown in many States of India
[2] A crop season from June to October
[3] A crop season from November to Februrary

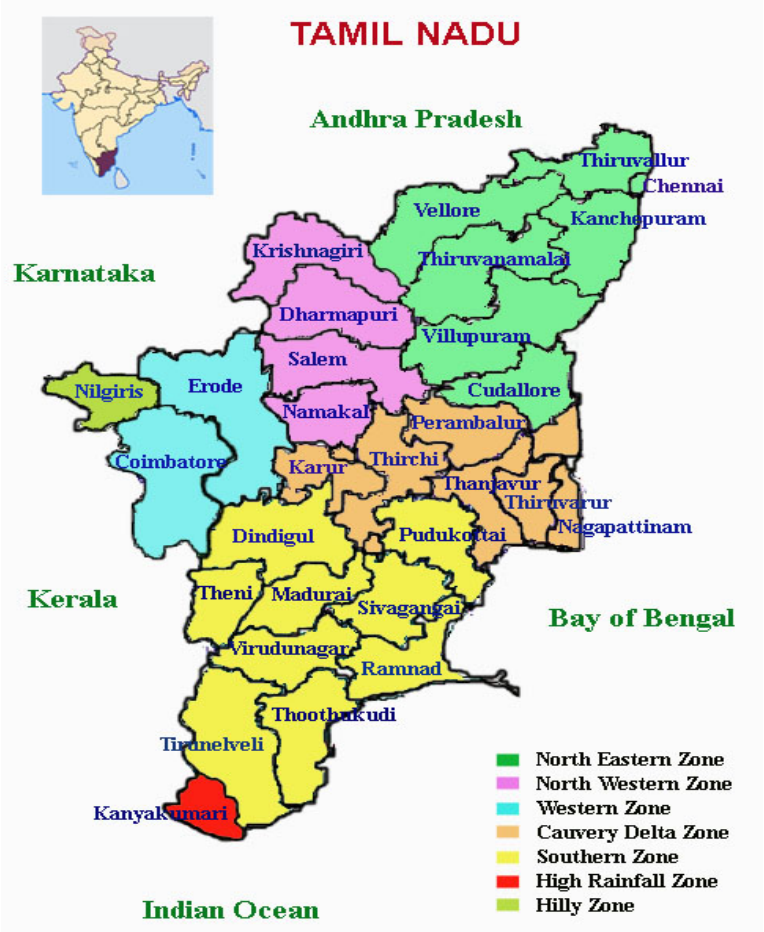

Figure 1. Agro Climatic Zones of Tamil Nadu and its Position in India (Inset)

4. Methodology

There are different indices used to measure crop diversification. These indices measure by a single quantitative indicator, the extent of dispersion and concentration of different crops at a given point of time and space, i.e., these indices are calculated for each 5 year time period from 1980-81 to 2005-06 for each coastal district of Tamil Nadu. Shiyani and Pandya (1998) also have used similar indices to study the diversification of agriculture in Gujarat State, India. Below we discuss the most commonly used indices of diversification and their properties.

(a) Hefindahl Index (HI)

The Hefindahl Index is the sum of the squares of the acreage proportion of each crop in the total cropped area. That is,

$$HI = \sum_{i=1}^{i=N} p_i^{\,2}$$

It can be shown that this index attains a minimum value equal to 1/N when p_i = 1/N (i = 1,2.3..N), and N is the total number of crops, that is, when maximum diversification occurs. It attains a maximum value of 1 when N = 1, that is, when there is a single crop or when complete specialization occurs.

(b) Entropy Index (EI)

This is a measure widely used by research workers. Unlike Herfindahl Index, the Entropy Index increases with increase in diversification. It is defined as

$$EI = -\sum_{i=1}^{N} p_i \ln(p_i)$$

It reaches a maximum value of log(N) when $p_i = 1/N$ (i = 1,2.3..N), that is, when maximum diversification occurs. It reaches a minimum value of 0 when there is only one crop, that is, when specialization happens. The EI has a limitation. Since the upper limit of EI is log(N) (which depends on N), it can't be used to compare the degree of diversification in different locations where different number of crops are grown. This limitation is overcome by defining a Modified Entropy Index.

(c) Modified Entropy Index (MEI)

This index is defined as

$$MEI = -\sum_{i=1}^{i=N} p_i \log_N (p_i)$$

Hence MEI is same as EI except that the base of the logarithm is N. It can be shown that at maximum diversification, this index takes a value of 1 and at maximum specialization it attains a value 0f 0. The MEI provides an uniform and fixed scale and hence it is used as a norm to compare and rank the extent of diversification spatially. Hence in the present study this index has been used to rank the different coastal indices. Table 2 provides a summary of the three different measures of diversification and their properties.

Table 2. Characteristic features of different measures of diversification

Index	**Formula**	**Measure of**	**Value at Perfect Diversification**	**Value at Perfect Concentration**	**Is ranking of activities possible?**
HI	$\sum_{i=1}^{i=N} p_i^{\,2}$	Concentration	1/N	1	No
EI	$\sum_{i=1}^{N} p_i \ln(p_i)$	Diversification	Ln(N)	0	No
MEI	$-\sum_{i=1}^{i-N} p_i \log_N (p_i)$	Diversification	1	0	Yes

5. Results and Discussion

The computed values of Modified Entrophy Index for the nine coastal district of Tamil Nadu are presented in Table 3.

Table 3. Crop Diversification Indices (Modified Entrophy Index) for Coastal Districts of Tamil Nadu.

District	Year					
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06
Kancheepuram	0.722	0.731	0.768	0.768	0.747	0.741
Cuddalore	0.634	0.637	0.717	0.688	0.623	0.622
Nagapattinam	0.414	0.426	0.469	0.370	0.397	0.414
Thanjavur	0.493	0.518	0.566	0.505	0.386	0.428
Pudukottai	0.449	0.519	0.574	0.515	0.425	0.453
Ramanathapuram	0.449	0.401	0.373	0.382	0.379	0.403
Tirunelveli	0.571	0.641	0.646	0.645	0.663	0.593
Thoothukudi	0.839	0.857	0.811	0.819	0.864	0.772
Kanniyakumari	0.319	0.413	0.408	0.376	0.509	0.516

The table shows that in coastal districts, the diversification index varied from 0.319 (corresponding to Kanyakumari during the year 1980-81) and 0.864 (corresponding to Thoothukudi during the year 2000-01). Kanniyakumari district registered maximum increase in the diversification index during the 25 years from 198 0-81 to 2005-06, whereas kancheepuram, Pudukottai and Tirunelveli registered marginal increase. All other districts registered decrease or remain unchanged diversification index during the study. The largest decrease in diversification was in Toothukudi district with a decrease of 0.057. Table 4 provides ranking of coastal districts based on Modified Entropy Index.

Table 4. Ranking of Coastal District of Tamil Nadu Based on Modified Entropy Index

District	Year					
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06
Kancheepuram	2	2	2	2	2	2
Cuddalore	3	4	3	3	4	3
Nagapattinam	8	7	7	9	7	8
Thanjavur	5	6	6	6	8	7
Pudukottai	6	5	5	5	6	6
Ramanathapuram	7	9	9	7	9	9
Tirunelveli	4	3	4	4	3	4
Thoothukudi	1	1	1	1	1	1
Kanniyakumari	9	8	8	8	5	5

The table 4 shows that Thoothukudi and Kancheepuram occupied first and second position in terms of crop diversification in the past 25 years. From table 3 the average diversification indices are respectively 0.827 and 0.746. This shows that in those district more than 75 percent agriculture land had been diversified to the nine crops taken for the study. Kanyakumari district has registered considerable increase in the rankings during the period of study. All other districts occupied the same position or ranking or decrease in ranking during the period of study.

6. Relationship between Crop Diversification Index Vulnerability and Resilience

Palanisam et al (2009) have examined the vulnerabilities of the costal districts of Tamil Nadu to climatic change. They have concluded that Ramanathapuram and Nagapattinam districts are most vulnerable to climatic change. The crop diversification indices of the two districts for the year 2005-06 (Table 3) are respectively 0.403 and 0.413 which means that only about 40% of the agricultural area are occupied by diverse crops. This show that there is an inverse relation between crop diversification and vulnerability to climatic change. Resilience in general refers to the level of resistance or recovery from shocks. In the case of coastal districts, the normal shock will be changes in rainfall resulting in floods or droughts, or other natural calamities. One of the major resistance identified was the cropping pattern changes in the coastal districts for the past 30 years. The area under food crops in coastal regions which was 88.8% during 1975-76 reduced to 82.7% during 2005-06 and the percentage area under non food crops increased from 11.2% to 17.3%. This clearly confirms that farmers in the coastal region are resilient to climatic changes by changing cropping pattern. Hence it is confirmed that crop diversification is considered as one of the resilient mechanism particularly in the coastal region.

7. Conclusion

It may be concluded from the results presented in the study that there exists wide spatio-temporal disparity in the diversification of crops in the coastal districts of Tamil Nadu. The diversification in the coastal districts can be effectively utilized by strengthening of the linkage between agricultural and industrial sectors. In those districts where the deceleration of diversification had been exhibited, efforts must be taken for singling out the causative factors and adoption of appropriate measures for augmenting the diversification. In this regard, the technology has a dominant role to play and as such adequate measures should be taken for propagating the innovative technologies in agriculture among the coastal farmers. Besides, diversification of enterprises should also be encouraged as a measure of minimizing the risk via resilience mechanism in those coastal districts where the index of diversification had showed plateau over years which will help to minimize the crop failure and income loss including employment to the rural people.

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