ANALYZING AGRICULTURAL REGIONALIZATION OF SIVASAGAR DISTRICT USING DOI'S METHOD

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Abstract
The approach and technique of Doi's method are based on a better and depth study of analyzing agricultural regionalization across the globe because the technique and approach of Doi's method promote the diversities in agro production with the help of the implementation of the crop combination method. The major objectives of this research paper are based on the study of analyzing agricultural regionalization using Doi's method under the approach of crop ranking and crop combination. These methods apply to Sivasagar District, Assam. Paddy, tea, vegetables, oil, nuts, and pulses were majorly cultivated in the study area. Agricultural Regionalization is made with the help of secondary data obtained from the agriculture-cropped area in Hectors, collected from the Ministry of Agriculture and Statistics, Govt. of India, Year 2014-15. By employing Doi's method, the study found out the ranking of the crops as well as the different crop combinations i.e., monoculture crop (Paddy) and Dual combination crops (Paddy and Tea) in the Sivasagar District. It can be recommended that the research paper can be helpful for the consideration of a mechanism among policymakers, researchers, academicians, and students regarding the study of Doi's method in analyzing agricultural regionalization in India.
Keywords: Agriculture; Crop Combination; Crop Ranking; Doi's method; Sivasagar.

Introduction
Agriculture Regionalization can be defined as various parameters including geographic location by climate and geomorphological structure in specific geographical regions. Agricultural regionalization can be functional and formal, and its boundaries are transitional and hierarchal. In the context of India, there are geographic variations and diversities in the sense of agriculture regionalization in specific geographic regions by geographic and climate conditions. These consequences play an important role in the development of agriculture in India as well as promote an agriculture-based economy in rural India in the context of the globalization of agriculture (Krishna, 1992). The method and approach of agricultural regionalization are based on various techniques including Weaver, Doi, and Koppek methods (Singh 2010). In the context of India, the approach and method of Doi give a realistic picture of the regionalization of agriculture in India according to the pattern crop combination. The pattern of crop combination is base for agricultural regionalization because first crop combination region to multiple crop combination regions creates a phenomenon of diversities in the agricultural belt of India. The technique of Geographical Information System (GIS) is an important tool in the process of determining crop combination regions according to the Doi method (Dayalan 2018). The Doi method is an important factor in the case of setting up agricultural regions according to the geographic conditions in the specific geographic region in southern India in the twenty-first century. There are trend-wise patterns and diversities in the agricultural regionalization from 2006-2007 to 2016-2017 in India (Dayalan 2021). These trend-wise patterns are associated with phenomena of the changing pattern of the agriculturally based economy in the consequences of globalization. In the consequences of globalization, it is also realized that there is a need to develop a better understanding and justification concerning the phenomena of implementation of Doi's method in analyzing agricultural regionalization in the context of crop combination in India.

According to Roy (1990), there is a cordial positive association between water and agricultural regionalization in the context of the pattern of population because the increasing trend of population

minimizes the agricultural lands as well as the burden of an agriculturally based economy. These consequences promote agricultural regionalization according to the dynamics of demography because trends in the growth of population increase pressure on agricultural land as well as increase the numbers of agricultural laborers compared to declining agricultural wage rates. The pattern of agricultural regionalization promotes agricultural efficiency in India. Result of an inter-regional pattern of an agricultural region, it is found that there are variations and diversities in the agricultural regionalization in the agricultural belt of India according to Doi's method. In the context of agriculture efficiency, the pattern of agricultural production gives an important role in the study of analyzing agricultural regionalization (Das 1993). There is a significant impact of Doi's method in determining agricultural regionalization with the approach of agriculture combination in the agricultural belt of Africa (Wowra et al. 2021).

The approach and technique of Doi's method is a universal technique for analyzing agricultural regionalization across the globe as well as emerged as a tool for measuring agro production. In the case of analyzing agricultural regionalization using Doi's method. There are regional variations and diversities in the pattern of agriculture in Iran. These consequences are improving the agro production in Iran as well as realizing that the method and approach of Doi's method are paving the way for analyzing agricultural regionalization according to the climatic conditions of Iran (Dinpashoh et al. 2004). The study of Arsenault et al. (2009) showed that Mexico is well known for its agro production in America as well as an exporter of vegetables and fruits across the globe. In these perspectives, the study also revealed that using Doi's method gives a realistic picture of the process, determinants, and consequences of a pattern of crop combination in Mexico as well as agricultural regionalization. This study also shows that the method and approach of Doi's method is an important tool and technique for analyzing the pattern of agricultural regionalization with promoting crop combination in agro production across the globe.

On the basis of the above concise introduction part, it is realized that the approach and method of Doi's method are based on the implementation of agricultural statistics in the study of agricultural patterns in the context of analyzing agricultural regionalization across the globe. Additionally, the introduction part also reveals that Doi's method is a universal approach in the study of patterns of agriculture in the periphery of crop combination because the consequences of crop combination promote agro production with its diversity and income of farmers. There is significant importance of Doi's method in the study of agricultural regionalization in the Sivasagar district because the social and economic implication of Doi's method is based on the better justification of the study of crop combination method on the ground level.

In the context of the background of the research paper, the study of process, determinates, and consequences of analyzing agricultural regionalization in the Sivsagar district of Assam in northeast India using Doi's method. Sivsagar district is well known for its geographic location and fertile plain in Assam. In these contexts, the next section of this paper is based on the critical analysis of the selected review of literature about the study of agricultural regionalization from the perspective of geography. In the case of the North-east region in India, the agricultural pattern of Sivasagar district is based on climatic conditions as well as agro production with its diversities. Therefore, the method and technique of Doi's method is an important tool for measuring agricultural regionalization in India.

Database and Methodology:

Agricultural Regionalization is made with the help of secondary data obtained from the agriculture-cropped area in Hectors, collected from the Ministry of Agriculture and Statistics, Govt. of India, Year 2014-15. Apart, secondary data is also collected from the district census handbook of Sivasagar district from geographic, economic, and demographic perspectives. The Doi's Method is utilized to determine the location quotient for determining the crop combination of each district. The Doi's approach, first introduced in 1957, is utilized in the Industrial Combination Structure in Tokyo, Japan. Since 1959, modified crops have been utilized in crop combinations. The current study

utilized Doi's crop combination in Sivasagar District. The objective is to demonstrate the adaptation of recent studies in order to showcase the unique combination of crops in the district.

About Study Area:

Sivasagar district, previously referred to as Sibsaga is one of the 34 districts of the state of Assam in Northeast India. The Sivasagar city serves as the administrative center for this district. This location is renowned for its abundant and diverse range of plant and animal species. The district of Sivasagar is situated in the Northeast India in Assam. The geographic location of Sivasagar district is 94.25 to 95.25 longitude and 26.45 to 28.15 latitude. The total geographic area of Sivasagar district is 1598.85 Sq.Km^2 and the total population is 1519386 according to the census 2011. The Sivasagar district is located next to the Naga Hills & Arunachal Pradesh in the south and southeast, respectively, and is bordered by the Brahmaputra River in the north. The district mostly consists of a level alluvial plain, with small hills located in the southeastern and southern regions along the Nagaland border. There is a total of 2 sub-division, 4 revenue circles, and 5 development blocks. Sivasagar district is well known for its biodiversity and agro production in Assam and India.

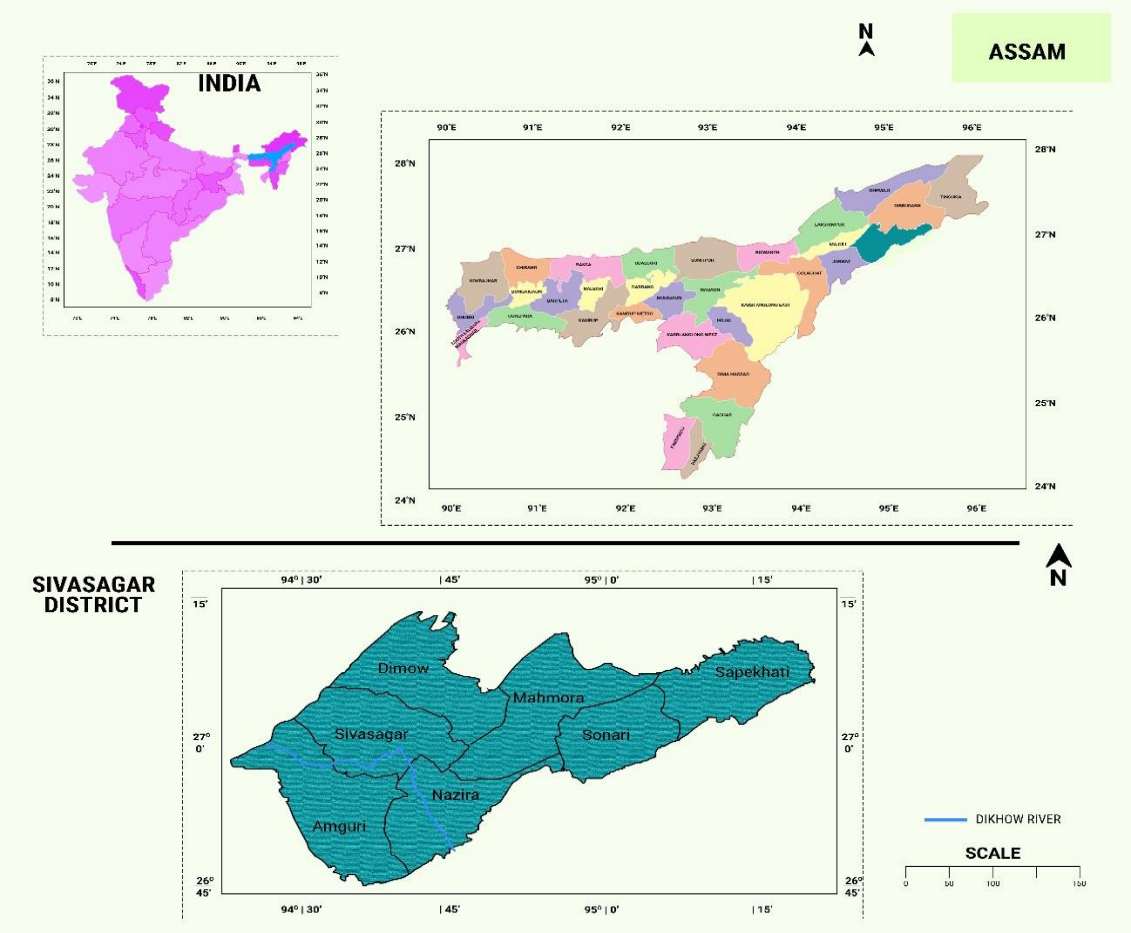

Figure 1.2: Sivasagar District

The above map shows that Sivasagr district is located in the upper side of Assam and this district is well known for its geographical connection with the rest of the states in the northeast region of India. Therefore, it is realized that the geographical location of the Sivasagar district gives basic phenomena about the socio-economic implication of agricultural patterns as well as the study of the pattern of agricultural regionalization using Doi's method. In these contexts, the next section of this paper is based on the analysis of an empirical-based survey and investigation according to the objectives.

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Crop Ranking

Table 1.1: Cumulative % of Crops

S.no.	Crops / Revenue Circle	Paddy	Oil	Nuts	Tea	Vegetables	Pulses
1.	Mahmora	66.17	1.14	1.60	23.11	5.68	0.69

Source: Self-prepared by Author

For instance, the percentage crops of Mahmora (Sivasagar district of Assam), area is given in Table 1.1. The maps are divided into several blocks, each representing a different village or town. The crops grown in each block are represented by different colors. The legend in the bottom right corner of the map shows which colour corresponds to which crop. The figure given below is a map of the Sivasagar district in Assam showing the ranking of crops. Overall, the map provides a useful overview of agriculture in the Sivasagar district.

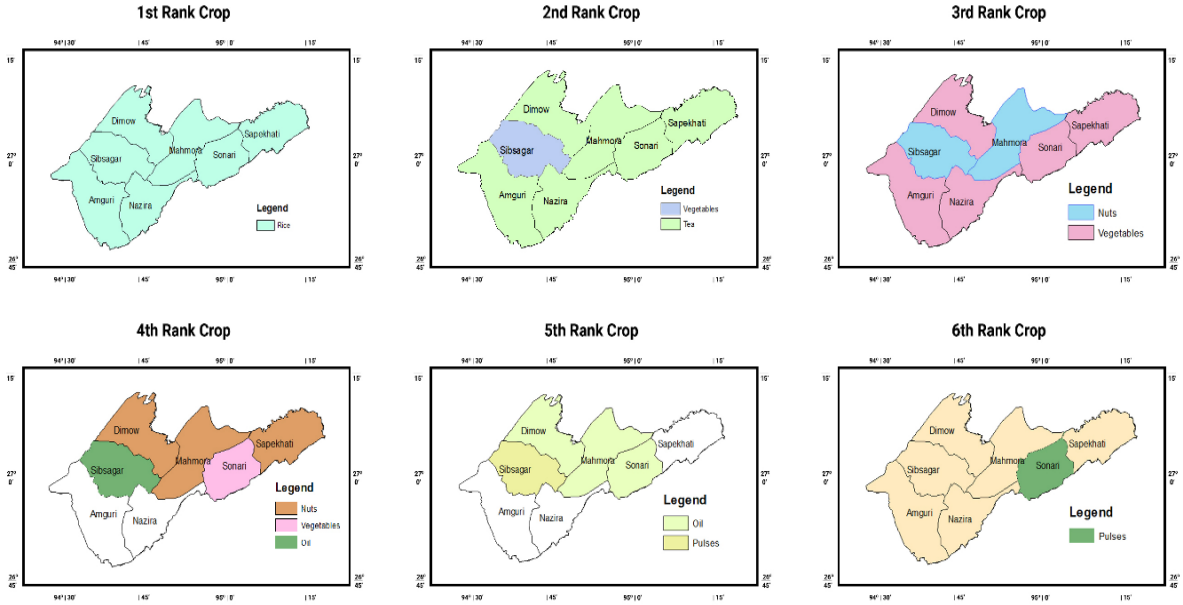

Figure 1.3: Crop Ranking in Sivasagar District of Assam
Source: Self prepared by Author

a. First Ranking Crop

According to the map, the most commonly grown crop in the Sivasagar district is paddy. Paddy comes in first rank because it is grown in almost all of the blocks in the district., having a cumulative percentage of 66.17% (Table 1.1). The crop that occupies the largest proportion of the total cropped area in every single block can be chosen, regardless of its proportion in the overall cultivated area. The block in the center of the map, Dimow, is the largest producer of paddy in the district.

b. Second Ranking Crop

Figure 1.3 shows the second-ranking crop grown in each block or revenue circle of the region, covering 6 regional circles (Mahmora, Dimow, Sapekhati, Sonari, Nazira, and Amguri) out of 7, in the Sivasagar District. Based on the cumulative percentage of crops, tea possesses the second ranking (i.e., 23.1) in Sivasagar District, after paddy (Table: 1.1). Tea (crop) is represented in green colour in the map. Tea plantations are a major industry in Assam, and Sivasagar is known for its high-quality tea.

c. Third Ranking Crop

The map shows vegetables as the third-ranking crop in the Sivasagar District, covering 5 regional circles (i.e., Dimow, Sapekhati, Sonari, Nazira, and Amguri) out of 7 regional circles in the Sivasagar District (Figure: 1.3). Also, as per table 1.1, the cumulative % of vegetables is 5.68%, which is the third highest in comparison to all other crops.

d. Fourth Ranking Crop

According to the map (Figure: 1.3), the fourth highest-ranking, grown crop in the Sivasagar district is Nuts, covering 3 regional circles (Dimow, Mahmora, and Sapekhati) in the Sivasagar District. The cumulative % of nuts is 1.60% (Table: 1.1). The nuts could refer to a variety of crops grown in the region, such as cashews, almonds, or betel nuts.

e. Fifth Ranking Crop

Fifth-rank crops dominated by oil seeds from the study area, having a cumulative percent of 1.14% (Table: 1.1), covering 3 regional circles (Mahmora, Dimow, and Sonari). The nuts are represented in orange color in the given map (Figure: 1.3).

f. Sixth Ranking Crop

The map shows pulses (yellow) as the sixth-ranking crop, meaning it's the sixth most common crop grown in each area, having a cumulative percentage of 0.69% (Table: 1.1). Pulses can be seen as the most-grown crop in Sivasagar district. Pulses could be a variety of legumes like lentils, chickpeas, or beans.

Doi's method: Crop combination and agricultural regionalization

Crop combination can be defined as the aggregate of various crops grown /cultivated in an area at a given point of time in different time and space contexts. Crop combination is the analysis of the total percentage of acreage area occupied by different crops in a given region in an agricultural year.

Doi (1959 & 1970) modified the Weaver (1954) technique in agricultural regionalization according to the following technique:

Crop combination index S= ∑d^2

Or

SD= $\sqrt{\sum d^2/n}$

n=numbers of crops in cropping combination,

d= differences between real percentage areal unit and theoretical curve.

This method demonstrates that crops with higher rankings exhibit a significant percentage, exceeding 10 percent, while the lower-ranking ingredient displays a percentage below 5 percent, typically being eliminated from the combination. This strategy is most effectively utilized in situations where there is an interaction between the component combinations, such as in the combination of crops. This method includes crops with a cumulative percentage of less than 50% in the combination. Alternatively, the critical value for all crops at various rankings compared to 50 is set to zero. Thus, the cumulative percentage scale starts above 50%.

The current analysis reveals that the first paddy crop in Sivasagar District accounts for 66.17% (Table 1.1) of the total, and subsequent crops are automatically added to ensure that the cumulative proportion exceeds 50%. The cumulative percentage of paddy, i.e., 66.17% falls within the range of 65 and 70. It is closer to 65 (critical value=18.38) (refer to Annexe- I), as the total of the percentages of the higher-ranking parts is referred to as mono-combination crops. The crop in question contributes to more than 50 percent of the total number of crops. For the Dual crop combination, the next crops, including paddy and tea, were evaluated based on their percentage contribution to the whole crop's worth, as indicated in the critical value table. The cumulative % of tea is 23.11% (second highest ranking). Thus, the tea is taken in combination with paddy, as per Doi's crop combination method, for dual crop combination.

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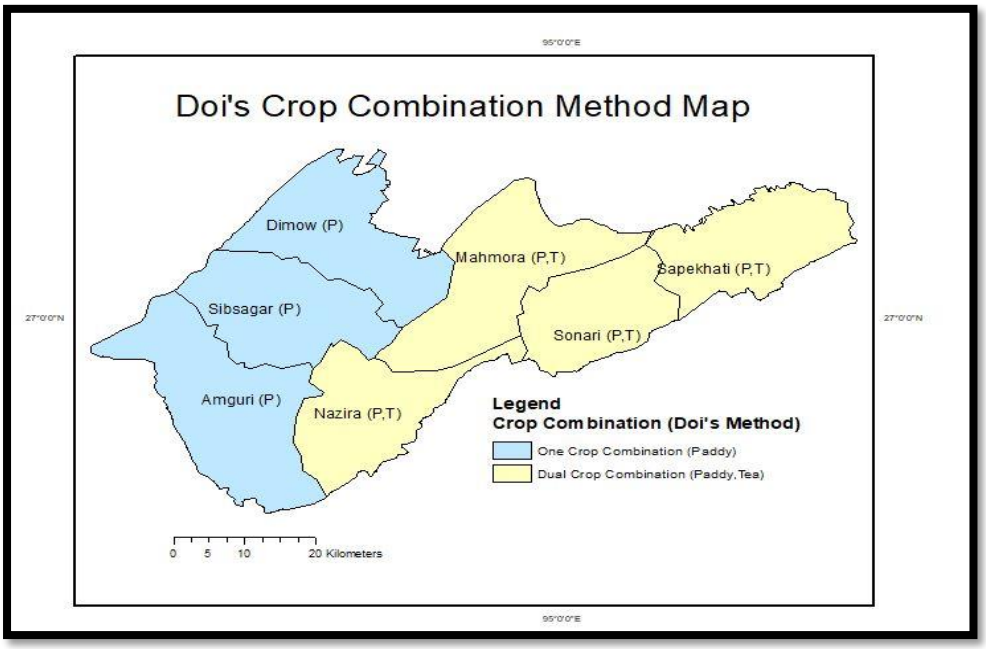

Figure 1.4: Crop Combination
Source: Self prepared by Author

a. Monoculture

Monoculture in agriculture refers to the cultivation of a single crop species in an area at a time. Monoculture is extensively employed in both intensive farming and organic farming. The mono-ranking crops dominate the majority of the overall agricultural production in the Dimow, Sivasagar, and Amguri regions (Figure 1.4). Paddy is extensively planted in these locations due to its ability to proliferate in areas with new alluvial delta soil, enough irrigation, and a diverse climate. The level of agricultural variety in this region is minimal.

b. Dual Crop Combinations

Double cropping refers to the practice of cultivating multiple crops in the same area and during the same year, hence maximizing the utilization of land to yield more than one crop year. Maize, peanuts, potatoes, and beans are commonly cultivated using double cropping techniques in Brazilian agriculture. The study examines the combination of paddy and tea as dual crops. The regions of Mahmora, Nazira, Sonari, and Sapekhati have the highest percentage of total crops occupied by Dual Crop Combinations (Figure 1.4). The research area yields data from four areas, which are distributed throughout seven regions. Consequently, cultivated regions are grown using a combination of crops that are well-suited to the climate, benefit from efficient irrigation, have fertile soil, and involve little crop variety. Consequently, farmers are motivated, and the study area experiences an increase in crop output.

Discussion

Based on the above concise description and explanation, it can be discussed that there is a significant impact of the crop combination in determining agricultural regionalization by using Doi's method in the perspective of promoting agro production based on agricultural regionalization. A study by Conrad et al. (2007) showed that the Indian agricultural irrigation system is also an important tool for analyzing agro production across India because the Indian agriculture system is based on the uncertainty of rainfall. The approach and technique of Doi's method are cordially associated with analyzing the pattern of agricultural regionalization by its process, determinants, and consequences in the periphery of the positive role of agro-based technology. Wowra et al. (2021) expressed that the approach and technique of Doi's method are key for exploring and understanding the phenomena of the agriculture region in the Sivasagar district of Assam. The study of Saikia et al. (2023) revealed that Paddy production is directly associated with the climatic conditions of the Northeast region of India as well as the income of farmers. In the case of a sample area of the Sivasagar district of

Assam, it can be discussed that there is a positive role of the approach and technique of Doi's method in the process of determining agricultural regionalization for better-enhancing agro-production under the technique of crop combination method of agricultural regionalization. According to Liu et al. (2020), there is a need to promote sustainable agro production for analyzing agricultural regionalization in the context of crop combination method with the approach and technique of Doi's method in India. However, the paper, give a critical based approach regarding analyzing the positive and negative sides of the implementation of Doi's method in the process of determining agricultural regionalization in the Sivasagar district of Assam in the consequences of globalization. Additionally, the study fills the existing gap in the review of literature as well as answer the unfolding facts about arguments. In these perspectives, the entire discussion part of this paper gives a base for developing an understanding of the process, determinants, and consequences of the implementation of Doi's method in analyzing agricultural regionalization. Finally, it can be finalized that both approach and technique of Doi's method give a positive role in the phenomena of analyzing agricultural regionalization in the Sivasagar district of Assam.

Conclusion

Based on the above concise discussion part, it can be concluded that there is a positive role and function of the approach and technique of Doi's method in analyzing agricultural regionalization in the Sivasagar district of Assam. Doi's method gives a kind of phenomenon concerning the determining role of the crop combination method in agro production. In these consequences, it is also realized that keywords of crop combination method are based on the better justification of analyzing agricultural regionalization with using of Doi's method in the consequences of globalization in the context of technology in enhancing agro production. Additionally, it is also realized that there is a need to develop such kind of model regarding the better justification of the role and function of Doi's method in analyzing agricultural regionalization in the agricultural belt of India. By employing Doi's method, the study found out the ranking of the crops as well as the different crop combinations i.e., monoculture crop (Paddy) and Dual combination crops (Paddy and Tea) in the Sivasagar District. It is also important to conclude that these phenomena are positively associated with the implementation of the role and function of Doi's method in analyzing agricultural regionalization in India, but the major problem is occurring concerning the unawareness of the implementation of the crop combination method in India. The study shows socio-economic and technical hurdles in the context of the use of Doi's method in analyzing agricultural regionalization in India.

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(Annexe- I)

Doi's Deviation Analysis Table

An Abridged Part of Deviation Analysis Table (One-Sheet Table)

Cumulative percentage of higher ranking elements	Rank of Element 1	2	3	4	5	6	7	8	9	10	11	12	13
	Critical Value												
95											6.98	6.27	5.68
90								8.84	7.60	6.67	5.94	5.35	4.49
85					12.93	10.00	8.17	6.91	5.99	5.29	4.73	4.29	3.91
80				13.83	10.00	7.85	6.46	5.49	4.78	4.23	3.79	3.33	3.14
75			16.67	10.57	7.75	6.13	5.06	4.32	3.76	3.33	2.99	2.71	2.49
70		27.64	12.25	7.93	5.96	4.65	3.85	3.29	2.87	2.55	2.29	2.08	1.90
65		18.38	8.66	5.63	4.19	3.14	2.77	2.37	2.07	1.84	1.65	1.50	1.37
60		11.27	5.46	3.59	2.68	2.14	1.78	1.52	1.33	1.18	1.06	0.97	0.88
55		5.38	2.68	1.73	1.29	1.04	0.86	0.74	0.64	0.57	0.52	0.47	0.43
50		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Doi, Kikukazu, "The Industrial Sturcture of Japan Prefectures", Tokyo, *Proceedings of the International Geographical Union*, Regional Conference in Japan, 1957, pp. 310-316.