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Analysis of the Agricultural Regionalisation Status Using the Geographical Information Techniques in Tiruchirappalli District (Tamil Nadu State, India) 2014-15

Dayalan, N., Triuchirappalli-Tamil Nadu

Abstract

Regionalization is the process of dividing an area into territorial units of uniformities and is the result of a set of processes. The agriculture regionalization status in the Trichirappalli Taluk is outlined, following by the discussion on the area under individual crops. Locational quotient method and for the combination analysis, J.C. Weaver's statistical method of crop combination has been followed. The diversification index is calculated with the use of Bhatia method. It lies between 10o10' and 11o20' of the northern latitudes and 78o10' and 79o0' of eastern latitudes in the centre part of the Tamil Nadu.The climate is generally high temperature and low humidity. With annual mean temperature of 28.9 C and annual rain fall is 800 to 1000 mm in the study area.This region is rich in Paddy crops which occupies more than 50 percentage of cropped area. The cropping pattern of the study area is assessed, to understand the proportion of various crops in the study area at 2014-15. This study is mainly derived from secondary data collected from the statistical office, the spatial variation in degree of crop concentration area are found to be the result of the different interaction such as physiographic, climatic, hydrological, socio-economic, technological factors.Thestudy results obtained using MS- Excel, Statistical Package for the social scientists (SPSS) and Arc GIS 10.1. Software

Key Words : *Cropping Pattern, Crop Concentration, Crop Combination, Lalgudi, Crop Diversification, Paddy.*

1. Introduction

The spatial distribution of crops their growth and response to physio-socio economic conditions prevalent in the study area. The cultivation of crops and their growth are closely related to the decision making process on one hand and adaptation of innovation in agriculture, i.e. use of high yielding varieties, improved and efficient implements, applications of chemical fertilizers and pesticides. The hectareage under individual crop gives relative strength and realistic picture of crop landuse in the analysis of crop ranking of the region. The ranks of crops and their combination provide spatial variation in the distribution patterns. In this respect the study of crop combination and diversification manifests the present agricultural scenario.

The study of crop combination regions constitutes an important aspect of agricultural geography as it provides a good basis agricultural regionalization. Crops are generally grown in combinations (Weaver,

1954). The study of crop combination of any region has gained importance in geographical study. It gives us the relative position of crops on regional scale. Farmers grow crops in varied physical and cultural conditions. The pattern of crop combination gives rise to spatial predominance of certain crops or combination results in the emergence of crop regions.The prime advantage of agricultural regionalization lies inthe fact that it helps in the formulation of agricultural planswhich is indeed useful to reducing the regional disparities. Such analysis would ultimately minimize the change of over simplified generalization (Ali, M. 1978). Crop combination study in geography is fruitful in many ways, firstly it provides an adequate understanding of an individual crop. Secondly, combination is in itself an integrative reality that demands definition and distribution analysis, and finally crop combination regions are essential for the construction of more complex structure of vivid agricultural region (Weaver, 1954). The study of crop combination thus forms an integral part of agricultural geography, and such study is greatly helpful for regional agricultural planning. First attempt for delineation of agricultural regions was made by Weaver in 1954. He studied crop combination for Middle East countries. Later on many more methods were introduced.

Agricultural regionalization is regarded as a device for clustering both visible and non-visible agriculturalphenomenon on the earth surface. Such device enablesgeographers to divide an area into several regions in termsof diversity present in agricultural system. It gives us the relative position of crops on regional scale (Ogale, 2014).

There arevarious methods of agricultural regionalization, most ofwhich is done by the help of agricultural statistics. Study ofcropping pattern and crop combination is by far the twomost familiar and universal methods of agriculturalregionalization. Unlike the previous findings, this study has been directed to upgradethe agricultural regionalization methods. The presentresearch work is trying to generate inputs by processing thedata using recent technologies like Geographicalinformation System (GIS) in cooperating with in situobservations and field verification (Panigrahy, 2005). Geographic Information System (GIS) is regarded as a set oftools for collecting, storing, transforming, and displayingspatial data from the real world observation for fulfilling thedesired. It is indeed ‘a system for capturing, storing,checking, integration, manipulation, analyzing anddisplaying data which are spatially referenced to the Earth(Burrough, 1986).

2. Study Area

Tiruchirappalli district is located at the central part of Tamil Nadu surrounded by Perambalur district in the north, Pudukottai district in the south, Karur and Dindigul districts in the west and Thanjavur district in the east. It lies between $10^{o}10'$ and $11^{o}20'$ of the northern latitudes and $78^{o}10'$ and $79^{o}0'$ of eastern latitudes in the centre part of the Tamil Nadu. The general slope of the district is towards east. It has a number of detached hills, among which Pachamalai hill is an important one, which has a peak up to 1015mt height, located at Sengattupatti rain forest. The climate is generally high temperature and low humidity. With annual mean temperature of 28.9 C and annual rain

fall is 800 to 1000 mm in the study area. Tiruchirappalli district comprised of elavan talukslike thatThuraiyur, Lalgudi, Musiri, Tiruchirappalli East, Tiruchirappalli West, Thiruverumpur, Marungapuri,Thottiyam , Manachanallur, Srirangam And Manapparai. The major rivers flows from study area like that Cavery river, Kollidam river, Uyyakkondan river, Upparu river, Ponnaniyaru river and Kudamurutti river but this all rivers non-perennial river or seasonal flowing rivers. These region 45.4 percentage occupied agriculture activities. The major crops cultivated in the region include Paddy, Banana, Vegetables, Coconut, Sugarcane, Ground nut, Pulses,Gingeley, Cholam, Cotton and Cumbu. The Paddy is the major crop and occupies 62 percentage of the total cropped area and 28.4 percentage of the total study area in 2014-15. It is cultivated largely in mid low land plain area. The alluvial soil with irrigation facility favours paddy cultivated in these areas. Banana is the second rank crop next to paddy and occupies 9 percentage of the cropped area. Vegetable is the third ranking in the study area. It is major factor is alluvial soil and irrigation facilities.

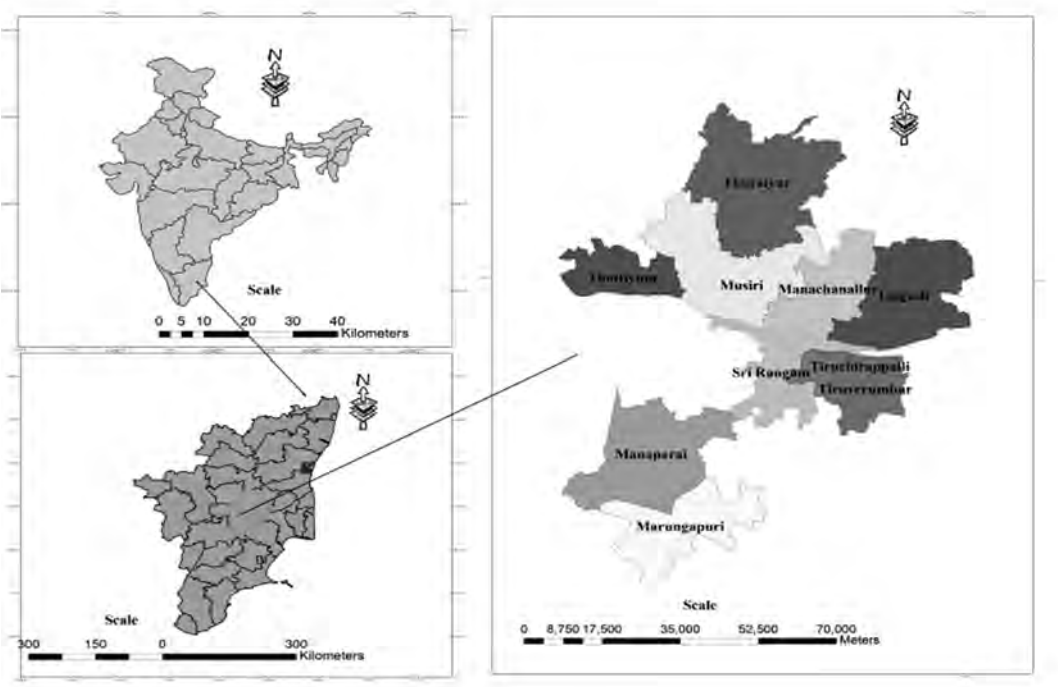

Fig. No. 1, Study Area, Trichirappalli Taluk

3. Aim And Objectives

In the present study different methods have been adopted to provide the spatial variation in the distribution patterns. In this study of crop concentration, Weaver's crop combination and Bhatiadiversification methods are used.

The major objectives have been put forth:

To interpret the factors responsible for the crop rank distribution and to determine the real strength of the crop.

To delineated the pattern of concentration and crops combination of the Tiruchirappalli Taluks by applying Weaver's method and plot it in a region of crop combination.

To identify the crop diversification patterns of the Tiruchirappalli taluks by applying Bhatia's method and find out the variables responsible for such patterns in the area under study.

4. Data Base And Methodology:

The entire study is based on secondary data whichhave been collected for various crops at 2014-15 from the Statistical Department and Agriculture Department in Tiruchirappalli District. The areas of crops have been converted into percentage (to Net Sown Area) which is later on, used for ranking of crops to identify the relative strength of individual crop. The Weaver's method has been applied to delineate the crop combination regions and crop diversification has been computed to understand the magnitude of the crop competition among the crops grown in the Taluks. Thestudy results obtained using MS- Excel, Statistical Package for the social scientists (SPSS) and Arc GIS 10.1. Software

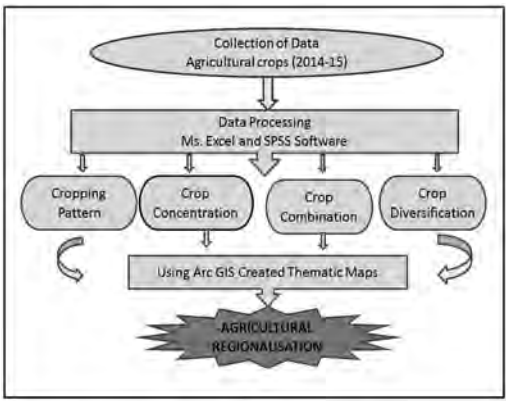

Fig. 2 Methodology from Present Study

5. Discussion

The present study has mainly examined the crop distribution, crop concentration, Weaver crop combination method and crop diversification in different taluks of Trichirappalli district; it envisages the different levels of diversification at taluk level like that low, moderate and high in the study area, mainly the spatial pattern of crop diversification. These will be the tools for future planning in case of crop production.

5.1. Cropping pattern

The cropping patterns of a region or areal unit may be determined on the basic of a real strength of individual crops. The first, second and third rank crop of an aerial unit may be called as the dominant crops of that unit. These crops, if occupying more or less the same percentage of the total cropped area, shall be competing for area with each other and the farmer will decide which crop may fetch him more profit in a given year under the prevailing rainfall and demand, supply and commodity price condition. In general, for the determination

of cropping pattern of a region the minor crop eliminated.

The relative yield index for determination of suitability of crop may be calculating by applying the following formula.

Relative yield index =

$$\frac{\textit{Mean yield of the crop in a compoent areal unit}}{\textit{Mean yield of the total area}} \boldsymbol{X\ 100}$$

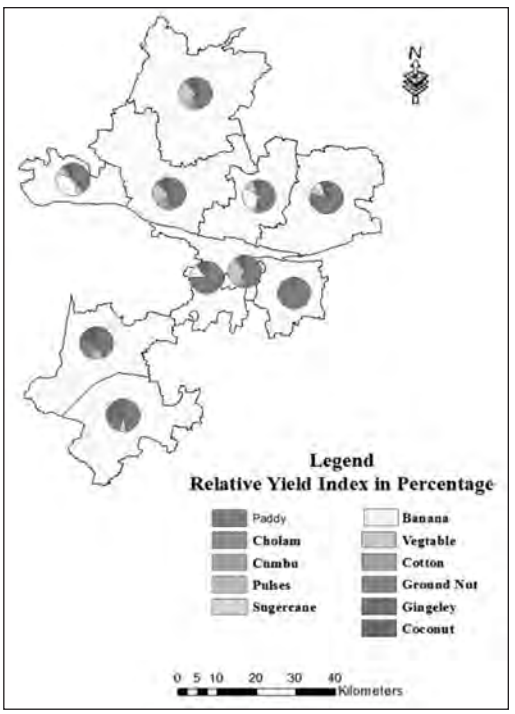

Fig. 3 Cropping Pattern in Tiruchirappalli Taluks

The present study region isLalgudi taluk which hashigh percentage of Paddy crop distribution and it occupies 41 percentage of the total cropped area in the taluk. It is cultivated largely in low land plain area. Sugarcane is the second rank crop occupied 4 percentages in the taluk.Gingelly is the third ranking crop of the taluk and confined only on the summer seasons remaining crop are cultivated in limited period in few part of the taluks.Paddy is the major crop in Mannapparai taluk and it occupies 12.8 percentage of the totalcropped area in that taluk. The Coconut is second ranked one. Others crops were cultivated in limited period in few parts of the taluk.In Manachanallur taluk, Paddy is the major crop and it occupies 14 percentage of the taluk. This region has good irrigation facility whichfavours Paddy cultivation in this study area. Vegetable is third ranking crop of study area, while other crops are cultivated in few percentage of the taluk.

In Marungapuri Taluk, Paddyoccupies 24.0 percentage of the total area in the taluk. Coconut occupies 15.8 percentage of the total cropped area in the taluk remaining crop ground nut occupies 7.3 percentage and sugarcane 2.9 percentage in the total cropped area. In Musiri Taluk, paddy occupies 12.1 percentage vegetable occupies 5.9 percentage Cholamoccupies 1.9 percentage Coconut (1.8%), Pulses (1.6%) and Ground nut (1.3%) in these taluks.

Srirangam and Trichirappalli taluk has highest percentage of Paddy (54.1), crop cultivation.It is inbasin of Cauvery River which also consists Alluvial Soil and irrigation facility. Remaining percentage cover the other crops in the taluk. In Tiruverumbur Taluk 90 percentage of land was cultivated with Paddy crop. Remaining percentage werecultivated with other minor crops. In Thottiyam and Thuraiyur taluk, Paddy has been the major crop which was cultivated of about 16 percentage of total agriculture land, remaining percentage occupies other crops such as Coconut, Vegetables, Sugarcane and Ground nut in that taluk.

5.2. Location Quotient Method of Crop Concentration

The locational quotient technique has also been applied for the determination of regional character of cropping patterns. In this techniques the regional character of crop distribution is investigated and determined, first by comparing the proportion of sown area under different crops and ranking them, and secondly, by relating the crop density in each of component areal units of the region to the corresponding density of the region as a whole. This approach makes it possible to measure the regional concentration of the crops objectively. It also helps to identify and differentiate areas that have some significance with regard to the crop distribution within the region.

The location quotient method may be expressed as under:

Index for Crop concentration =

$$\frac{\text{Area of X crop in the component areal unit}}{\text{Area of all crops in the component areal unit}} \div \frac{\text{Area of Xcrop in the entire region}}{\text{Area of all crops in the entire region}}$$

By applying the above technique, if index value is greater than unity, the component areal unit accounts for a share greater than it would have had if the distribution were uniform in the entire region, and therefore, the areal unit has a concentration of great agriculture significance. The main advantage is delineation of crop concentration lies in the fast that it enables the geographers and planners to understand the area specialization of different crops grown in a region at a given point of time and period.

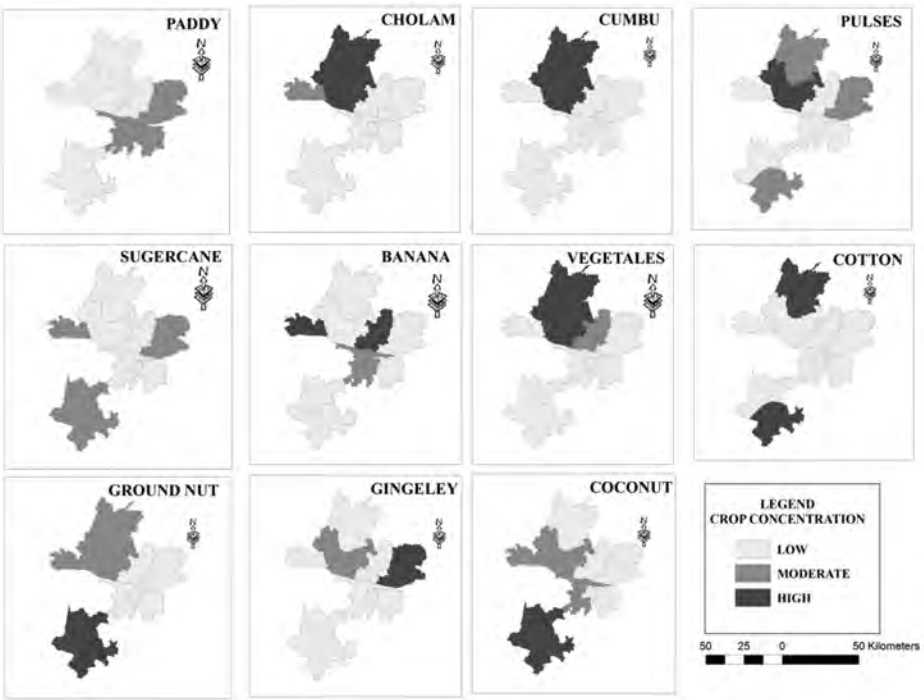

Fig. 4 Location Quotient Method of Crop Concentration

Table 1 : Crop Concentration Index in Tiruchirappalli Taluks

Taluks	Crop Concentration		
	High	**Moderate**	**Low**
Laugudi	Gingeley	Sugarcane, pulses, paddy	Banana, Cotton, Cumbu, Vegetables, Ground nut, Coconut, Cholam
Manapparai	Ground nut, cotton, coconut	Sugarcane, pulses	Cumbu, Paddy, Vegetables, Gingeley Cholam, Banana
Mannachanallur	Banana	Vegetables	Coconut, Paddy, Pulses, Sugarcane, Cumbu Gingeley, Ground nut, Cholam, Cotton
Marungapuri	Coconut, Ground nut	Sugarcane	Paddy, Cotton, Pulses, Vegetables, Cholam, Gingeley, Banana, Cumbu
Musiri	Cumbu, Cholam, Vegetables, Pulses	Ground nut, Gingeley	Coconut, Cotton, Sugarcane, Paddy, Banana
Srirangam		Banana, Coconut, Paddy	Sugarcane, Vegetables, Cholam, Pulses, Cotton, Ground nut, Cumbu, Gingeley
Thiruverumpur		Paddy	Pulses, Gingeley, Sugarcane, Banana Coconut, Cholam, Ground nut, Cumbu, Vegetables, Cotton
Thottiyam	Banana	Cholam, Sugarcane, Ground nut, Coconut	Vegetables, Pulses, Cotton, Paddy, Gingeley, Cumbu
Thuraiyur	Vegetables, Cumbu, Cotton, Cholam	Pulses, Ground nut	Gingeley, Paddy, Sugarcane, Coconut, Banana
Tiruchirappalli		Paddy, Banana	Pulses, Coconut, Sugarcane, Cumbu, Cholam, Vegetables, Cotton, Ground nut, Gingeley

Source: Compiled by Author based on G- return data(2014-15) 0f Districts Statistical Office, Trichirappalli

The relationship between density of individual crop and the corresponding density for the study area as a whole has been studied. According to table no:-1showing the taluk wise crop concentration index in Trichirappalli taluk. The pattern of crop concentration in the region is as follows.

5.2.1. Lalgudi

Lalgudi major cultivable land in the study area because here though located in the Cauvery basin is enough to meet requirement, even then area is enjoying fairly good irrigation facilities to facilities agriculture cultivation without risk. The higher level of concentration crop in Gingeley in the study area remaining Sugarcane, pulses and paddy having moderate level to low concentration then this crop occupy in the Banana, Cotton, Cumbu, Vegetables, Ground nut, Coconut and Cholam of the taluk.

5.2.2. Manapparai

InManapparai taluk,Ground nut, Cotton and Coconut has high degree level of concentration where remaining crops such as Sugarcane and Pulses has moderate level of concentration. The Cumbu, Paddy, Vegetables, Gingeley, Cholamand Banana has low level of concentration in these taluk.

5.2.3. Mannachanallur

The Mannachanallur is another important taluk in this study area. The High degree level of concentration goes toBananaand moderate level goes toVegetables and low concentration goes toPaddy, Cotton, Pulses, Vegetables, Cholam, Gingeley, Banana and Cumbu in this taluk.

5.2.4. Marungapuri

In Marungapuri taluk, the concentration was high in Coconut and Ground nut.Remaining crops such as sugarcane has moderate level of concentration. Low level concentration is seen in Paddy, Cotton, Pulses, Vegetables, Cholam, Gingeley, Banana and Cumbu in the taluk.

5.2.5. Musiri

Musiri has high concentration crops such asCumbu, Cholam. Vegetables and Pulses such as Ground nut and Gingeleywere in moderate level and low concentration crops such as Coconut, Cotton, Sugarcane, Paddy and Banana of the taluk.

4.2.6. Srirangam

The Srirangam is Inland Island in the world, it is a Famous pilgrimage tourist spot. Thisregion has moderate crop concentration ofBanana, Coconut and Paddy; remaining crop has low concentration in the taluk.

4.2.7. Thiruverumpur

The Paddy crophasmoderate concentration; remaining crop is low in the taluk.

4.2.8. Thottiyam

Thottiyam is major river basin taluk in the study area. High crop concentration found is Banana; remaining,Cholam, Sugarcane, Ground nut and Coconut were moderate to low concentration of the Taluk.

4.2.9. Thuraiyur

The Vegetables, Cumbu, Cotton and Cholam hashigh degree level concentration; remaining Pulses, and Ground nut hasmoderate level to low concentration of the Taluk.

4.2.10. Tiruchirappalli

The Tiruchirappalli east and west taluks, Banana, Pulses and Paddy crop has moderatelevel ; remaining crop has low concentration in this Taluk.

5.3. Crop Combination (Weaver's Method)

In the field of agricultural geography Weaver was the first Geographer who used (1954) statistical technique to show the crop combination of the Middle West USA. In his attempt for the delineation of agricultural regions of the Middle West in the United States, Weaver based his analysis on acreage statistics. Weaver computed the percentage of total harvested cropland occupied by each crop that held as much as one percent of the total cultivated land in each of the 1081 counties covered his work.

Table 2 : Crop Concentration Index

Crop Combination	Description
Monoculture	100 % of the total harvested crop land in one crop
Two crop combination	50 % in each of Two crops
Three crop combination	33.3 % in each of Three crops
Four crop combination	25 % in each of Four crops
Five crop combination	20 % in each of Five crops
Ten crop combination	10 % in each of Ten crops

Source : Systematic Agriculture Geography, MajidHussin

For the determination of the minimum deviation the standard deviation method was used:

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

Where'd' is the difference between the actual crop percentages in a given county (areal unit) and the appropriate percentage in the theoretical curve and n is the number of crops in a given combination.

As Weaver pointed out, the relative, not absolute value being significant, square roots were not extracted so, the actual formula used as follows: $d = \sqrt{d^2}/n$. To illustrate the Weaver's technique an illustration can be given from Trichirappalli District in which the percentage share of crops in the cropped area in a year 2014-15.

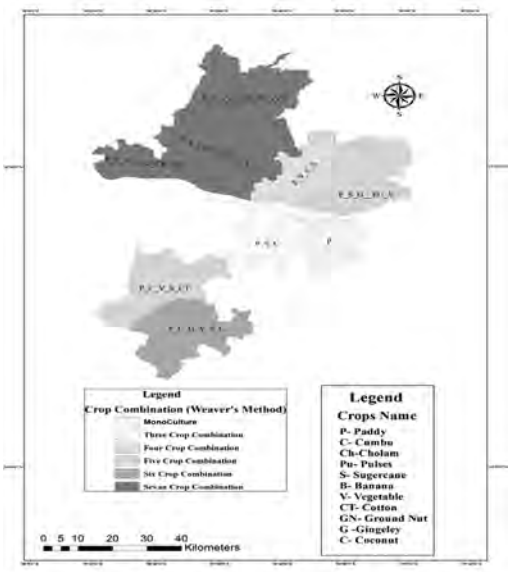

Fig. 5 Weaver's Method: Various Values Combination 2014-15

Table 3 : Crop Combination in Tiruchirappalli Taluks

No. of Crops	Crop Combination	No. of Taluks	Region/ Taluks
Monoculture	Paddy	1	**Thiruverumpur**
2 - crop combination	Nil	0	Nil
3- crop combination	Paddy + sugarcane + coconut	2	**Srirangam**
	Paddy + pulses + coconut		**Trichy west**
4- crop combination	Paddy+ vegetables+ coconut+ sugarcane	2	**Mannachanallur,**
	Paddy+ coconut+ pulses+ sugarcane		**Trichy east**
5- crop combination	Paddy + sugarcane +gingeley+ pulses+ vegetables	2	**Laugudi,**
	Paddy+ coconut+ ground nut+ sugarcane+ vegetables		**Marungapuri**
6- crop combination	Paddy+ coconut+ ground nut+ vegetables+ sugarcane+ cotton	1	**Manapparai**
7- crop combination	Paddy+ vegetables+ cholam+ coconut+ pulses+ ground nut+ sugarcane	3	**Musiri,**
	Paddy+ coconut+ vegetables+ sugarcane+ ground nut+ cholam+ pulses		**Thottiyam,**
	Paddy+ vegetables+ cholam+ ground nut+ pulses+ coconut+ sugarcane		**Thuraiyur**

Source: Compiled by Author based on G- Return Data(2014-15) 0f Districts Statistical Office, Trichirappalli

The theoretical standard as follows: 100 percentage of the gross cropped area is monoculture, 50 percentage is for two crop combination, 33.33 percentage is for three crop combination, 25 percentage is for four crop combination, 20 percentage is for five crop combination and so on. The present application of map reveals that there are maximumseven crop combination region in Tiruchirappalli taluk at 2014-15. Mono culture of cultivation:paddy in found Tiruverumbur Taluk. There are three crop regions with Paddy, Sugarcane and Coconut in Sri Rangamtaluk ;Paddy, Pulses and Coconut are noticed in Trichirappalli Taluk. Four crop combinations were found in two taluks namely Manachanallur and Trichirappalli West Where Paddy, Vegetables, Coconut, Pulses and Sugarcaneare major crops. Fivecrops combination regions were found in two taluks such asLalgudi and Marugapuri. Only one six crop combination region was found inManapparaitaluk and Seven crop combination in Three region like thatMusiri, Thottiyum and Thuraiyur taluk are noticed during 2014-15. (Fig. No.:-4 and Table: 1)

5.4 Diversification

The crop-combination technique is applied to compute crop-diversification pattern of the region. Its meaning is to raise variety of crops on arable land. It reflects the impact of physio-socio-economic variables. Moreover, it shows the contemporary competition among crops for an area, scope for rotation, the effect on double cropping, (Husain, 1979). The greater numbers of crops lead to greater competition, the higher is the magnitude of diversification.

Many geographers and economists so far have applied the concept of diversification in variety of sense. This concept, initially, was applied in the field of manufacturing to identify the degree of diversifications and concentrations by Cleann (1930), later on, by Tree (1938), Florence (1942) and Rainwald (1949). Gibb Martin (1974) has used diversification concept in computing measurement of diversification of employment in industry. Among geographers, Bhatia (1965) adopted and introduced crop diversification technique in order to understand crop competition in the region followed by Jasbir Singh (1976); Ayyer (1969) modified Bhatia's method of crop diversification with accounting for those crops which occupy at least one per cent of the gross cropped area.

In order to identify spatial pattern of crop diversification in Present study, Bhatia's method has been adopted in modified form. The crops having less than five percentages have been excluded from computation. This modified formula expresses as:

Index of Crop Diversification =

$$\frac{Percentage\ of\ Net\ Sown\ Area}{Number\ of\ "N"\ crops}$$

This main advantage of crops diversification is that it provides a relationship between the relative areal strength of the crops grown in region. The larger, the number of crops having about 10 per cent of the gross cropped area, the higher is the crop diversification in the region. In fact, it is an indicator of multiplication of agricultural activities which obviously involve intense competition among various activities for space.

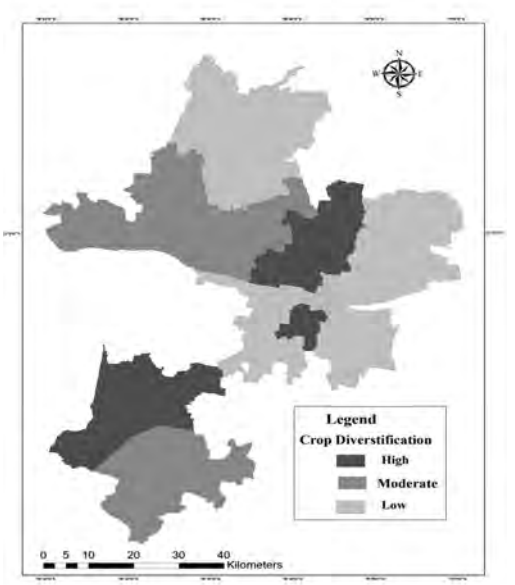

Fig. 6 Crop Diversification in Tiruchirappalli Taluks

The present study area has high degree of crop diversification which closely influenced by the soil characteristics, soil moisture, amount of rainfall received, the availability of irrigation facilities, the accessibility of the arable land and the technology deployed by the cultivators. The present regions have been shown in Fig. No.3. It is seen in Thuraiyur, Lalgudi, Tiruverumbur,

Tiruverumbur and Sri Rangamwhich have the lowest degree of crop diversification. In fact, this area has monoculture or three crop combination, specializing either Paddy, Sugarcane and Coconut. The Thottiyum, Musiri and Marungapuri have moderate level of diversification, while Maanachanallur, Trichirapalli taluk and Manapparai have a high degree of crop diversification in the study area. (Fig. No.: 4)

The main advantage of a map showing the level of diversification lies in the fact that it helps in the future planning and development of agriculture. The regions which have a high degree of diversification are generally the areas extreme moisture conditions and areas erratic rainfall. The areas of high diversification of crops deserve special attention of planners for development of agriculture. A comprehensive plan for each of the region of high diversification may go a long way in enhancing their agriculture productivity and in reducing the region inequalities in agriculture development. There is increasing awareness among the exports of agriculture that crop diversification with suitable crop rotation is necessary for the maintenance of soil health and for making agriculture more productive and sustainable.

6. Conclusion

It is clear from the above analysis that taluks having largest proportion of the area has been covered by Paddy crop which occupies the 62.8 percentage of total agriculture area. Remaining percentage of area was cultivated with Banana, Vegetables, Coconut, Sugarcane, Ground nut, Pulses, Gingeley,Cholam, Cotton andCumbu. The patterns of crop concentration identify the eleven major crops in the study area. They arePaddy, Banana Coconut,Vegetables, Cotton, Gingeley, Sugarcane, Ground nut, Cholam, Pulses and Cumbu. The pattern of diversification according the Bhatia's Method, low diversity is noticed only in Tiruverumbur, Lalgudi, Thuraiyur and Sri Rangam taluks and other taluks hasmoderate and higher crop intensity. The study of crop combination region is an important aspect of agriculture geography as it provides a good basis for agriculture regionalization. The crops are generally grown in combination and it is rarely observed, that, a particular crop occupies a position of total isolation than other crops in a given time. (Weaver, 1954). Monoculture was found in one taluk and Three to five crop combination were found in 6taluks and four taluks has more than five crops combination and they are categorized as multi crops, for example, a farming field has atleast 3 or 4 intercrops, in order to understand the agriculture situations, the land use pattern of the region. In future, the proposal of crop combination could be utilized.There should be increasing awareness among the exporters about the agricultural crop regionalization and understanding of suitable crop rotation is necessary for the maintenance of soil health and for making agriculture more productive and sustainable. The main advantage of present study, it helps in the formulation of agricultural plans which may go a long way in reducing disparities in inequalities.

Bibliography

1. Ali, Mohammad (1978): "Dynamics of Agricultural Development in India". Concept Publication, Private Company - New Delhi.
2. Athawale, A.G. (1966): "Some New Methods of Crop-combination", Geographical Review of India, Kolkata, December, Pp. 28-34.
3. Bhatia, S. S. (1965). Pattern of Crop Concentration and Diversification in India. *Economic Geography*, Vol.*4, No.1*, pp39-56.
4. Bhat, M. M. (2013). Agricultural Land-Use Pattern in Pulwama District of Kashmir Valley. *International Journal of Economics, Business and Finance*, Vol.*1* No.5, pp80-93.
5. Coppock, J. T. (1964): "Crop Livestock and Enterprise Combinations in England and Wales," Economic Geography, Vol.40, PP. 65-77.
6. Doi K, "The industrial structure of Japanese PerfectureProceding", I. G. U. Regional conference in Japan, 1959, 310-316.
7. Dayalan N. ,Analysis of The Industrial Combination Structure based on Doi's Method: Case Study of Tamil Nadu Cauvery Basin (India). Cloud Publications, International Journal of Advanced Earth Science and Engineering 2017, Volume 6, Issue 1, pp. 557–566 ISSN: 2320–3609, Crossref: 10.23953/cloud.ijaese.297
8. Gopal Das (2013). The Study of Crop Combination Regions in Jalpaiguri District, West Bengal. *Acme International Journal of Multidisciplinary Research*, Vol.*1No.*9, pp27-33.
9. Kavitha D &Aruchamy S, "Development of dynamic thematics for cropping pattern using GIS", Int. Jor. OfCurrent Research and Academic Review, Vol. 1, 2013, pp. 57-68.
10. Majid Husain (1996). *Systemmatic Agricultural Geography* (1996 ed.). Jaipur, India: Rawat Publications
11. Motebennur S S, "Crop Combination Regions in Karnataka With Special Reference to Major Edible Oilseeds", Indian journal of applied research, Nov,2014.
12. Mohammad A, "Dynamics of Agricultural Development in India". (Ed.), Concept Publication, Private Company - New Delhi, 1978.
13. Panigrahy S and Manjunath K R, "Deriving cropping system performance indices using remote sensing and GIS", International Journal of RS, 2005, 26 (12), pp. 2595-1606.
14. Najmul Islam Hashmi, &Gomatee (2013). International Journal of Innovative Research and Development,.*Pattern of Crop Concentration and Diversification in Upper Ganga Yamuna Doab* , Vol.*1, No.*5, pp481-496.
15. Noor Mohammad (1970) : "Crop-Combination in Trans-Ghagsa Plain". Geographical Review of India, Kalkutta, 32/1.
16. Ogale S B, "A study of crop combination region ", International Journal. ofInovation and Scientific Research, Jun 2014, pp329-334.
17. Patil, B. D. (2013). A Geographical Analysis Of Spatio - Temporal Variation In Cropping Intensity & Concentration Of Irrigated Crops In Dhule & Nandurbar Districts (ms). Nandurbar Districts (ms). *Indian Streams Research Journal*, Vol.*3,* No.11, pp1-6.
18. Priyadharshni. S, Dr. S. Aruchamy Agricultural Regionalization Based on Cropping Pattern in Sweta Nadhi Basin, Tamil Nadu, International Journal Of Innovative Research & Development, Vol 3 Issue 13, December, 2014, Page 216 to 223.

19. Rathod.H.B, Naik.V.T. (2009). Agricultural Land Use Cropping Pattern In Yavatmal District. *Shodh, SamikshaaurMulyankan (International Research Journal)*, Vol.*2*, No.6, pp780-782.

20. Shahidullah, S. M., Talukder, M. S.A, Kabir, M. S., Khan, A. H., &Nur-E-Elahi (2006). Cropping Patterns in the South East Coastal Region of Bangladesh. *Journal of Agriculture & Rural Development*, Vol.*4*, *No.*2, pp53-60.

21. Sharma, S.C. (1971) : "Cropping Pattern and Crop-Combination Regions in Etweal Middle Ganga Yanuna Doab". The Deccan Geographer, Secunderabad, 10/1.

22. Singh, H. (1963) : "Crop Diversification in Malwa Tract of Punjab." The Indian Geographical Journal, Madras, Vol.38, 3 and 4.

23. Jasbir, S., &Dhillon, S. S. (1984). Methods of Agriculture Regionalization. In *Agricultural geography* (3rd ed., pp. 213-297). New Delhi, India: Tata McGraw-Hill.

24. SushmaPanigrahy, Ray, S. S., Anil Sood, Patel, L. B., Sharma, P. K., &Parihar, J. S. (2004). Journal of Indian Society of Remote Sensing. *Analysis of Cropping Pattern Changes in Bhatinda District, Punjab*, Vol.*32, No.*2, pp209-216.

25. Todkari, G. U. (2012). A Study of Crop Combination InSolapur District Of Maharashtra. *Journal of Crop Science*, Vol.*3, No.*1, pp51-53.

26. Weaver, J. C. (1954). Geographical Review, American Geographical Society. *Crop Combination Region in the Middle West*, Vol.*44*, *No.*2, pp175-200.

Dayalan, N.
Guest Lecturer,
Department of Geography,
Periyar E.V.R College (Auto.),
Triuchirappalli-620023, Tamil Nadu, India.