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PATTERNS OF CROP CONCENTRATION AND DIVERSIFICATION IN AIYAR BASIN, CENTRAL TAMIL NADU

M. Gomathi
K. Kumaraswamy

Abstract

The study analyses the spatial pattern of agricultural crops in Aiyar basin at village level using the secondary data collected for six years (2010-11 and 2015-16). By comparing the relative strength of various crops, the first and second ranking crops for each village have been identified and mapped based on percentage of net sown area. The spatial distribution of first and second ranking crops reveals that paddy (the principle wet crop) and sorghum (the principle dry crop) occupy first rank in their categories over extensive parts of the study area. The distributional pattern of these two crops reflects the availability of irrigation facilities. Indices of the crop concentration and diversification of crops have been calculated and mapped to study the spatial patterns of crop concentration and diversification. In general, it has been found that the diversification of crops is high all over the study area. However, the villages having higher proportion of area under paddy, sorghum or tapioca have recorded very low level of crop diversification.

Introduction

India is one of the leading agricultural countries of the world where largest income comes from agricultural produce (Singh, 1990). Even though the country's agricultural production has increased four-fold since independence, the growth in agriculture is highly regionalized. The regional differences in agricultural development arising out of varied physical resource endowments tend to get further accentuated, because of varying levels of investment in rural infrastructure and in technological innovations (Bhalla and Singh, 1997). Indeed, the study on regional dominance of crops is essential to understand the agricultural development of an area. The areal domination of certain crops in their varied combinations can be best studied by attempting some kind of synthesis (Dayal, 1967). There are many methods to regionalize the agricultural practices but the most frequent attempts are; to study the patterns of ranking of crops, crop concentration and crop diversification. These quantitative techniques clearly exhibit the spatial relationship of crops and land utilization (Todkari, 2012). One among the classic studies on agricultural regionalization was the attempt of Bhatia (1965) who investigated the regional character of crop distributions in a quantitative manner. In order to determine the regional concentration of crops, he introduced a location quotient index technique which offered a new line of approach in agricultural geography. He determined the regional dominance of crops by

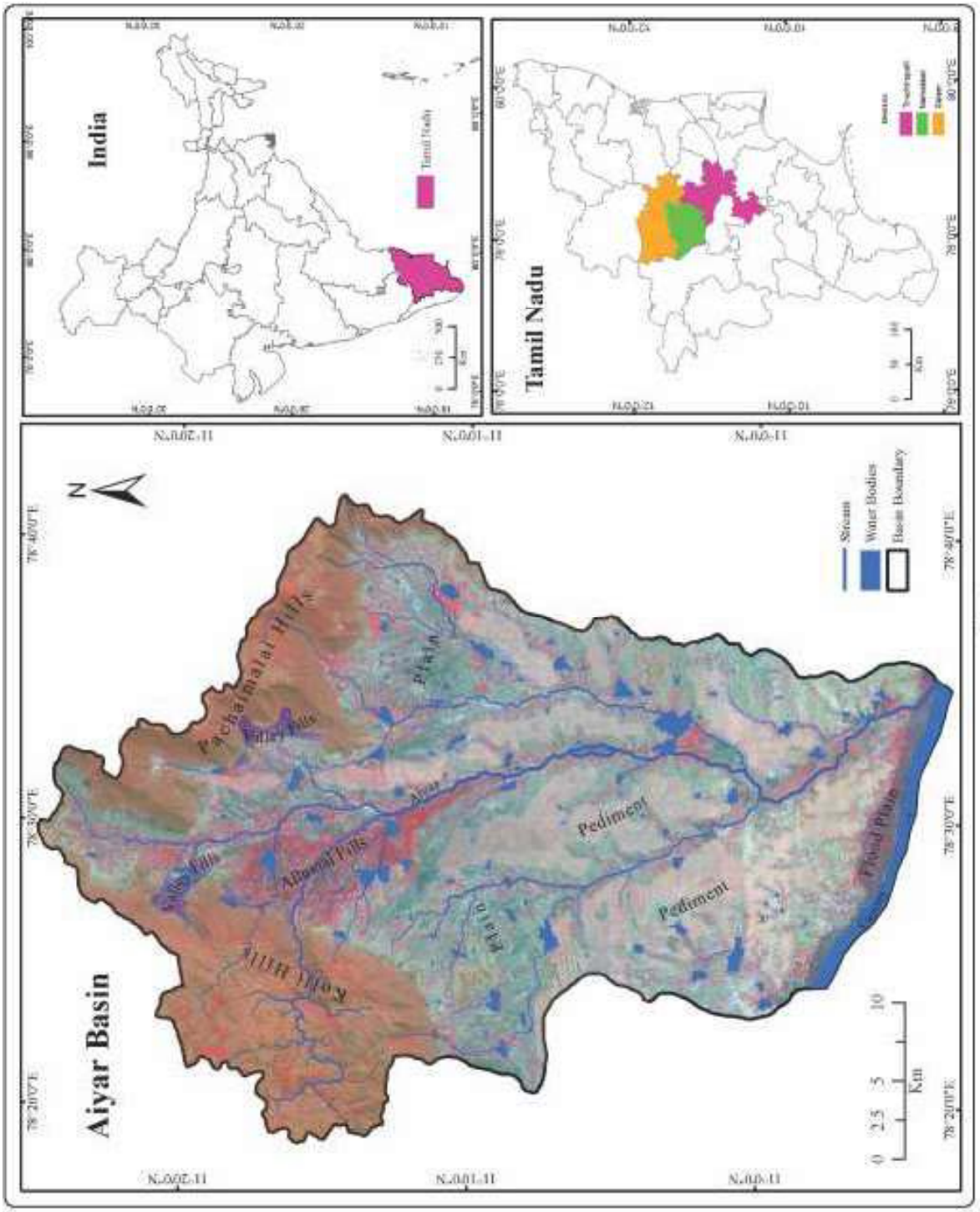

India
Tamil Nadu
Aiyar Basin
Stream
Water Bodies
Basin Boundary
Pachamalai Hills
Valley Fills
Alluvial Fills
Kolli Hills
Plain
Pediment
Flood Plain
Km

Fig. 1

comparing the proportion of sown area under different crops and ranking them by relating the crop density in each of the component areal units of the country to the corresponding density for the country as a whole. Similarly, several studies like those by Shafi, (1960), Nath, (1969), Singh and Chauhan, (1977) and Bhalla and Tyagi (1989) have also highlighted the agricultural growth and development processes in their regional context. Such studies have also emphasized on the suitable cropping pattern in relation to existing agro-ecological conditions and socio-economic conditions. Of late, several scholars have adopted these approaches to analyze the cropping patterns on a regional basis with a view to bring out the areal concentration and diversification of crops (Singh, 1994; Shiyani and Pandya, 1998; Bhalla and Gurmail, 2001; Singh and Bimal, 2003; Nawshaba and Motiur, 2012; Gopal, 2013; Jegankumar et al., 2015; Rao and Bhaskara, 2015). Hence, by considering the merits of agricultural regionalization, the present research has been attempted to analyze the cropping patterns of Aiyar basin with a view to bring out the areal variations in concentration and diversification of crops.

Objectives of the Study

The major objectives of this study are:

- To assess the relative strength of various crops;
- To understand the areal variations in concentration of dominant crops and
- To investigate the degree of crop diversification in the study area.

Study Area

Aiyar basin is a part of Cauvery river basin and it covers parts of Tiruchirappalli, Namakkal and Salem districts of Tamil Nadu (Fig. 1). It extends between 10° 53′ to 11° 25′ North latitude and 78° 19′ to 78° 41′ East longitudes. The river Aiyar rises between the Pachaimalai hills and Kolli hills and flows towards south to a distance of about 40 km and joins the river Cauvery near Upper Anicut. The total area of the basin is about 1,360 km² divided into 130 revenue villages. Besides the main river Aiyar, ponds, canals and small streams play a key role in promoting agricultural activities of the study area. The geomorphology of this region comprises of pediplains, alluvial plains, structural hills, residual hills, valley fills, pediments, buried pediments, and upland plateau with undulating plain. Soils in this region are predominant of black cotton soils, red sandy to loamy soils, alluvial soils and sandy soils (Wilson et al., 2012). The average temperature in the study area varies from 24°C to 41°C with an average annual rainfall of about 600-1,100 mm. According to 2011 census data, the average population density of the basin is 450 persons per km² (Gomathi and Kumaraswamy, 2014). The economy of the study area is dominated by agriculture which together with the allied activities forms the most important source of employment and revenue. Though, in general, the proportion of the net sown area to the total geographical area is about 42 per cent, yet there is appreciable variation in the use of land for agriculture. The foot-hills of Kolli and Pachamalai hills have higher proportion of net sown area supported by fertile soils and good groundwater potential.

Database and Methodology

The Aiyar basin is covered by 130 revenue villages falling in three districts of Tiruchirappalli, Namakkal and Salem. The agricultural data pertaining to these villages

have been collected from District Statistical offices of Tiruchirappalli, Namakkal and Salem districts for the period between 2010-11 and 2015-16. In order to nullify the short term variations in agricultural pattern, the six years data have been averaged and normalized on village scale. The study is based on a consideration of the proportion of cropland under fifteen major crops (paddy, sorghum (cholam), tapiocca, pulses, total vegetables, groundnut, spices, maize, fodder, cotton, banana, sunflower, coconut, sugarcane and korai). These crops accounted for 90.2 per cent of the total cropped area during the study period. To study cropping patterns, a comparison of the relative strength of various crops is made by ranking them for each village according to the percentage of net sown area occupied by each crop.

In order to determine the regional concentration of crops, the location quotient index of Bhatia (1965) is calculated as below:

$$\text{index of crop concentration} = \frac{\dfrac{\text{area of x crop in a village}}{\text{area of all crops in the village}}}{\dfrac{\text{area of x crop in entire basin}}{\text{area of all crops in entire basin}}}$$

Similarly, an index developed by Gibbs-Martin (1962) has been adopted for identifying the degree of crop diversification. It is a useful index for measuring the relative extent of crop diversification in a unit of area and it is expressed as:

Index of Diversification = $(\sum X^2)/(\sum X)^2$

where, X represents the percentage of each crop that occupies more than 5 per cent of the total cropped area of a village. If the index value is close to one, the diversification is relatively high which indicates that the area is evenly distributed among the crops. If a village is devoted to a single crop, then the index value is zero i.e. farmers practice monoculture.

Finally, geographical information techniques have been used to analyze and integrate the results to prepare thematic maps.

Results and Discussion

Distribution of Crops by Ranking

In the study of cropping patterns, it is necessary to know the areas where different crops dominate. It can be normally done by comparing the relative strength of various crops and ranking them for each village based on percentage of net sown area occupied by each crop (Bhatia, 1965). The spatial distribution of first and second ranking crops reveals the regional dominance of various crops at a glance (Fig. 2 and 3).

(i) First Ranking Crops

The crops such as paddy, sorghum, tapiocca, vegetables, groundnut, spices, maize, cotton, banana, sunflower, sugarcane and korai are found to be first ranking crops in one or more villages (Fig. 2). Paddy and sorghum are first ranking crops over extensive parts of the study area comprising about 75 per cent of the villages. The distributional pattern of the dominance of these two crops reflects differences in availability of irrigation facilities. Broadly, this pattern is brought out by the dominance of paddy in the valley-fills and flood plain regions and sorghum in the pediments. Both the crops hold first rank in nearly 75 per cent villages of the basin (Table 1). Out of these two, sorghum as a first ranking crop is the most widespread and occupies first position in 53 villages (Table 1).

Paddy on the other hand occupies first rank among crops in central part of the basin and along the river Cauvery. Paddy ranks first in 44 villages and it is a leading crop of the basin in terms of total cultivable area (25 per cent of total net sown area; Table 1). All villages along the main rivers have paddy as the first ranking

Table 1
Aiyar Basin: Net Sown Area and Ranking of Crops

Crop	No. of First Rank Villages	No. of Second Rank Villages	Total Net Sown Area (ha)	Net Sown Area (%)
Paddy	44	43	15113	24.9
Sorghum	53	14	12615	20.8
Tapioca	10	06	6330	10.4
Pulses	-	17	3804	6.3
Vegetables	05	07	3712	6.1
Groundnut	01	13	3349	5.5
Spices	01	04	2870	4.7
Maize	04	06	2784	4.6
Fodder	01	06	2403	4.0
Cotton	04	05	1962	3.2
Banana	01	04	1226	2.0
Sunflower	01	01	1129	1.9
Coconut	-	02	1037	1.7
Sugarcane	01	-	925	1.5
Korai	04	-	798	1.3
Coffee	-	02	576	0.9

Source: Compiled by Authors

crop. In a village of Kolli hills too (Valavanthi Nadu), paddy holds the first position. Sorghum holds first rank over most parts of southern basin. The area where sorghum is the leading crop closely coincides with the semi-arid pediment regions. The region of sorghum dominance is divided into two parts by a narrow belt where paddy ranks first. This wedge that splits the sorghum area is formed by the Aiyar river valley with fertile soil and abundant supply of water (Fig. 2).

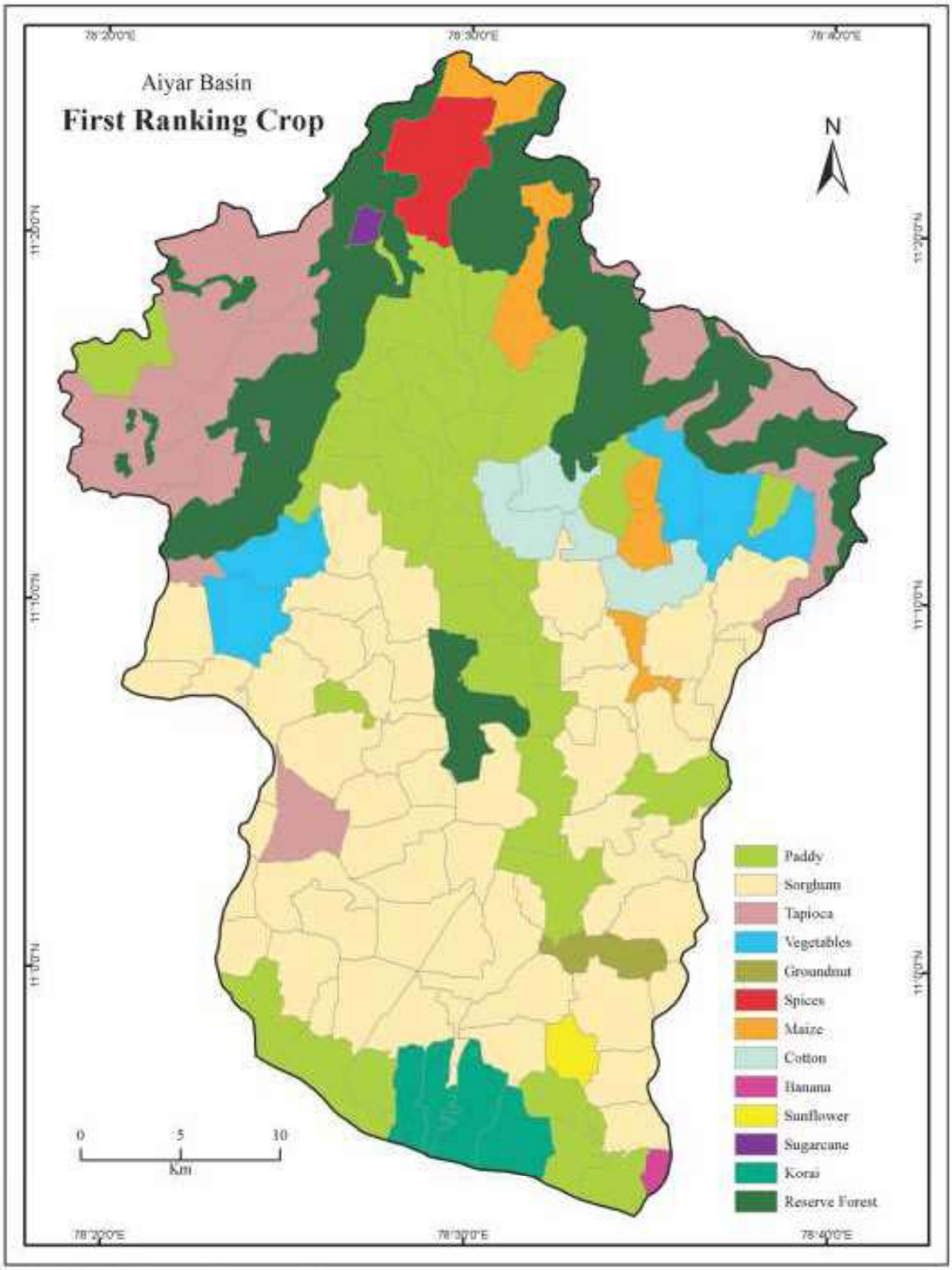
Spices, banana, sugarcane, groundnut, fodder and sunflower, hold first rank only in one village each. Cotton and vegetables hold first rank in four and five villages respectively, located in the foot-hills of Kolli and Pachaimalai hills, and in an area where concentration of paddy declines to some extent.

Maize holds first ranking position in four villages, forming a north-south axis parallel to the left side of Pachaimalai hills. Korai occupies first rank in four villages located along the river Cauvery. Tapiocca is an important cash crop in most of the Kolli and Pachaimalai hills and ranks first in villages of these upland regions. An isolated village (Sergudi) with tapioca as the leading crop lies farther to the central-west of the study area (Fig. 2).

(ii) Second Ranking Crops

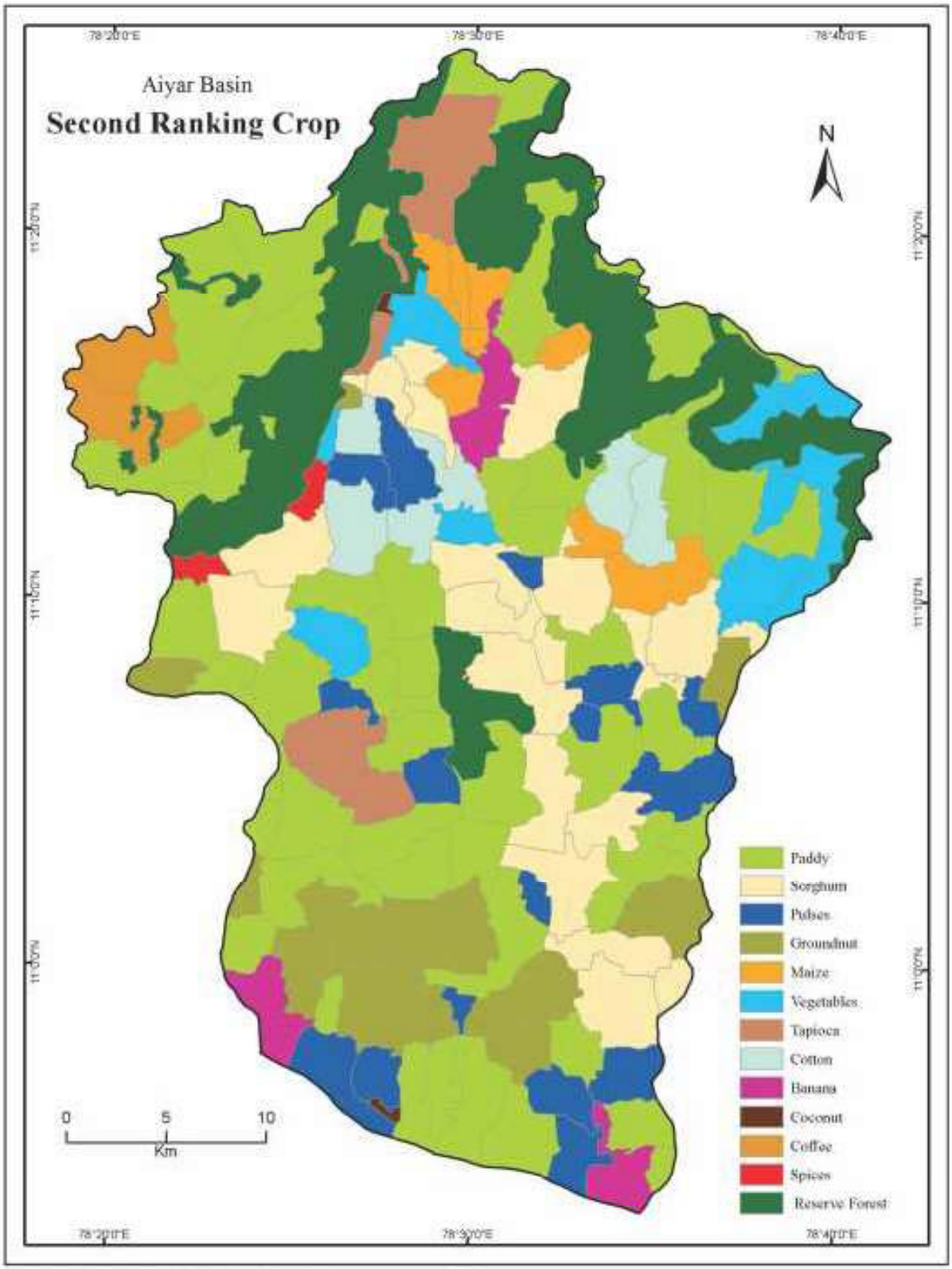
Like first ranking crops, a total of 12 different crops attained second position in one or more villages (Fig. 3). The second ranking crops are; paddy, sorghum, pulses, groundnut, maize, vegetables, tapiocca, cotton, banana, coconut, coffee and spices.

Pulses as a second rank crop have been mainly observed in southern part of the basin and coffee attains second position in western most villages of Kolli hills. Coconut attains second position in two villages located in floodplains and Kolli foot-hills. Almost half of the study area is dominated by paddy and



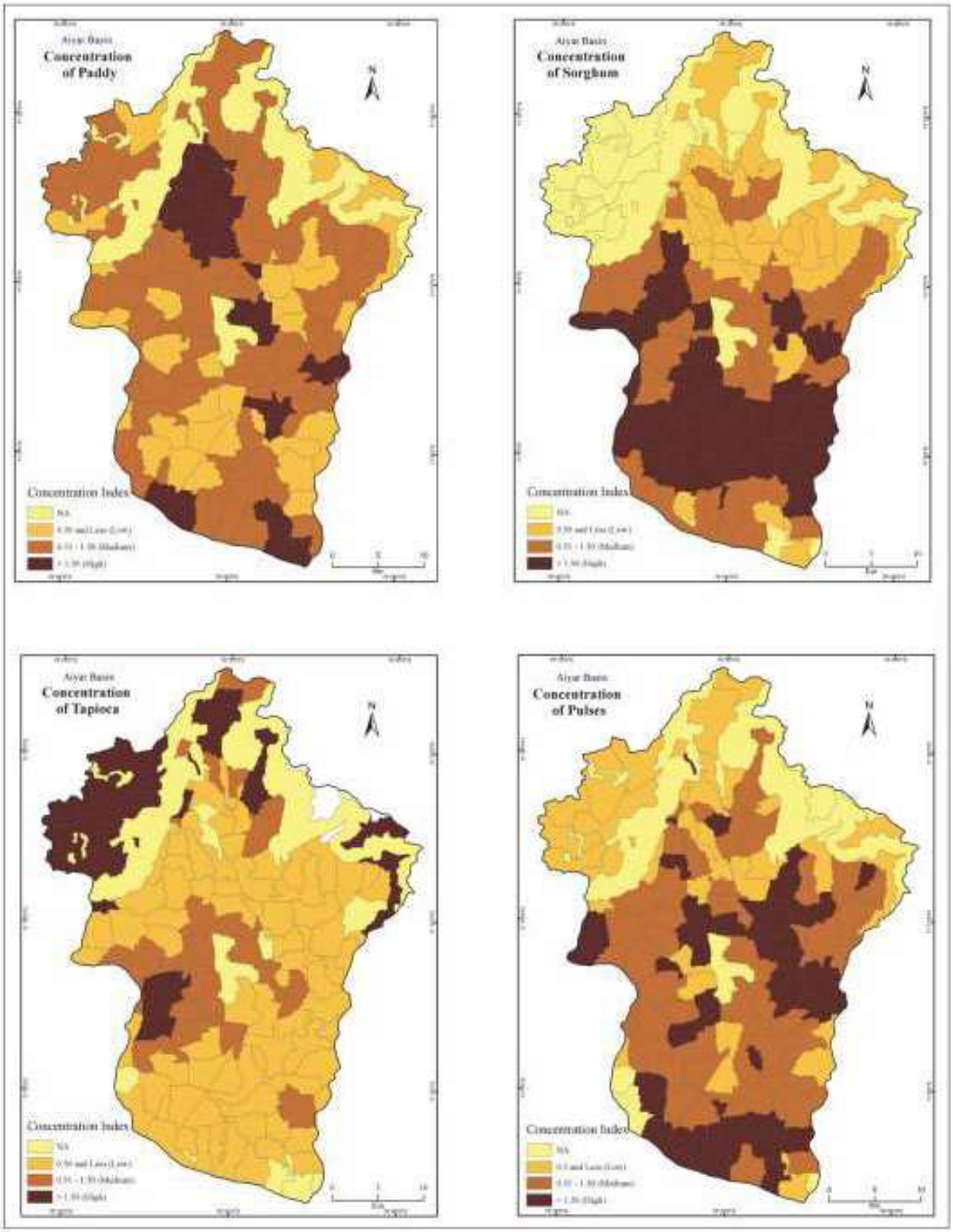
Source: Dept. of Economics & Statistics, GoTN

Fig. 2



Source: Dept. of Economics & Statistics, GoTN

Fig. 3



Source: Dept. of Economics & Statistics, GoTN

Fig. 4

sorghum reflecting the influence of seasonal rainfall. Paddy occupied second position in most of the villages where sorghum is a first ranking crop and vice-versa. This pattern of crop rotation shows the general tendency of the farmers to sow paddy during north-east monsoon *(rabi)* season (October-December) and sorghum during summer period (March-May). The distributional patterns of other second-ranking crops are much fragmented and can best be seen on the map (Fig. 3).

Patterns of Crop Concentration

Although the crop ranking maps, based upon a comparison of relative strength of different crops within a village, bring out the general patterns of crop dominance, yet spatial concentration of different crops and character of their dominance in the entire basin has been determined by the method of crop concentration. The patterns of concentration of ten leading crops (paddy, sorghum, tapioca, pulses, vegetables, groundnut, spices, maize, cotton and banana), from among the 15 crops that appear on the first and second ranking crop have been mapped and investigated as under:

(i) Paddy

Paddy is an important wet crop cultivated in all the villages of the study area. Over one- fourth of the total cropped area is devoted to paddy in the basin as a whole but villages located in the floodplain and alluvial-fill have comparatively higher concentration of paddy. The area of high concentration of paddy coincides with the fertile soil and intensively irrigated areas. The villages such as Balakrishnampatti, Kallathukombai, Alathudaiyanpatti, Kottapalayam, Nallamathikombai, Patchaiperumalpatti and Puliyancholaikombai located in the valley-fill region where river Aiyar descends down from Kolli hills have higher concentration of paddy. The zone of medium concentration occurs on the margins of the high concentration area. In fact, of the total 130 villages, 99 villages fall under these two categories of high and medium concentration which highlights the importance given to the paddy by the farmers (Fig. 4).

(ii) Sorghum

The main concentration of sorghum (Cholam) is observed over the pediment region of the Aiyar basin. The share of sorghum to the total cropped area is about 21 per cent (Table 1). Being harder in nature, sorghum gains importance in the drier parts of the study area, especially between northern alluvial-fill and southern floodplain. In general, the distributional patterns of the concentration of paddy (main wet crop) and sorghum (main dry crop) are mutually exclusive (Fig. 4).

(iii) Tapioca

Tapioca is an important commercial crop of the study area which supports sago industries in and around the study area. The major area of concentration of tapioca lies in the Kolli hills. The two minor areas of tapioca concentration lie over Pachamalai hills and central western part of the basin (Fig. 4). It thrives in undulated regions and requires minimal human efforts. About 10 per cent (Table 1) of the total cropped land in the basin is devoted for tapioca cultivation and the proportion of this crop is steadily increasing year-by-year. Tapioca along with other major crops such as paddy and sorghum occupy about 56 per cent cropped area of the study region (Table 1).

(iv) Pulses

Almost the entire plain region of the study area is occupied by medium to high

concentration of pulses. The high concentration area brings out the core region where pulses are best suited and emerge as the second ranking crops in many villages (Fig. 3 and 4). It is interesting to note that the distributional patterns of the concentration of sorghum and pulses are not only mutually exclusive but the separation line between the two is well defined. The areas of high concentration of sorghum and pulses overlap only in ten bordering villages and, in all of these; low concentration of paddy is noted. This indicates that crop distribution in the basin mainly depends on concentration of paddy wherever the topography and irrigation facilities are conducive for it; else the farmers prefer either sorghum or pulses.

(v) Vegetables

High concentration of vegetables is found in two distinct zones separated from one another by areas of high concentration of paddy. Both of these zones of high concentration of vegetables are located in the Kolli and Pachamalai foot-hills (Fig. 5).

(vi) Groundnut

Groundnut is concentrated in almost the entire plain region of the study area. However, the high concentration of groundnut occurs in the southern half of the basin (Fig. 5). Groundnuts thrive well during the dry season on the southern parts of the basin as it requires minimum soil moisture.

(vii) Spices

Spices and coffee are significant crops of hill environment for their value than the total acreage. High concentration of spices is found over Kolli and Pachamalai hills. All the villages of Kolli hills have high concentration of spices except Devanur Nadu and Gundur Nadu villages where the concentration of tapioca is very high (Fig. 5).

(viii) Banana

The regional pattern of banana plantation clearly shows three distinct zones i.e. river valleys in Kolli hills, alluvial fills between Kolli and Pachamalai hills and flood plains of river Cauvery. All these regions are marked with fertile soils and irrigation facilities (Fig. 5).

(ix) Maize

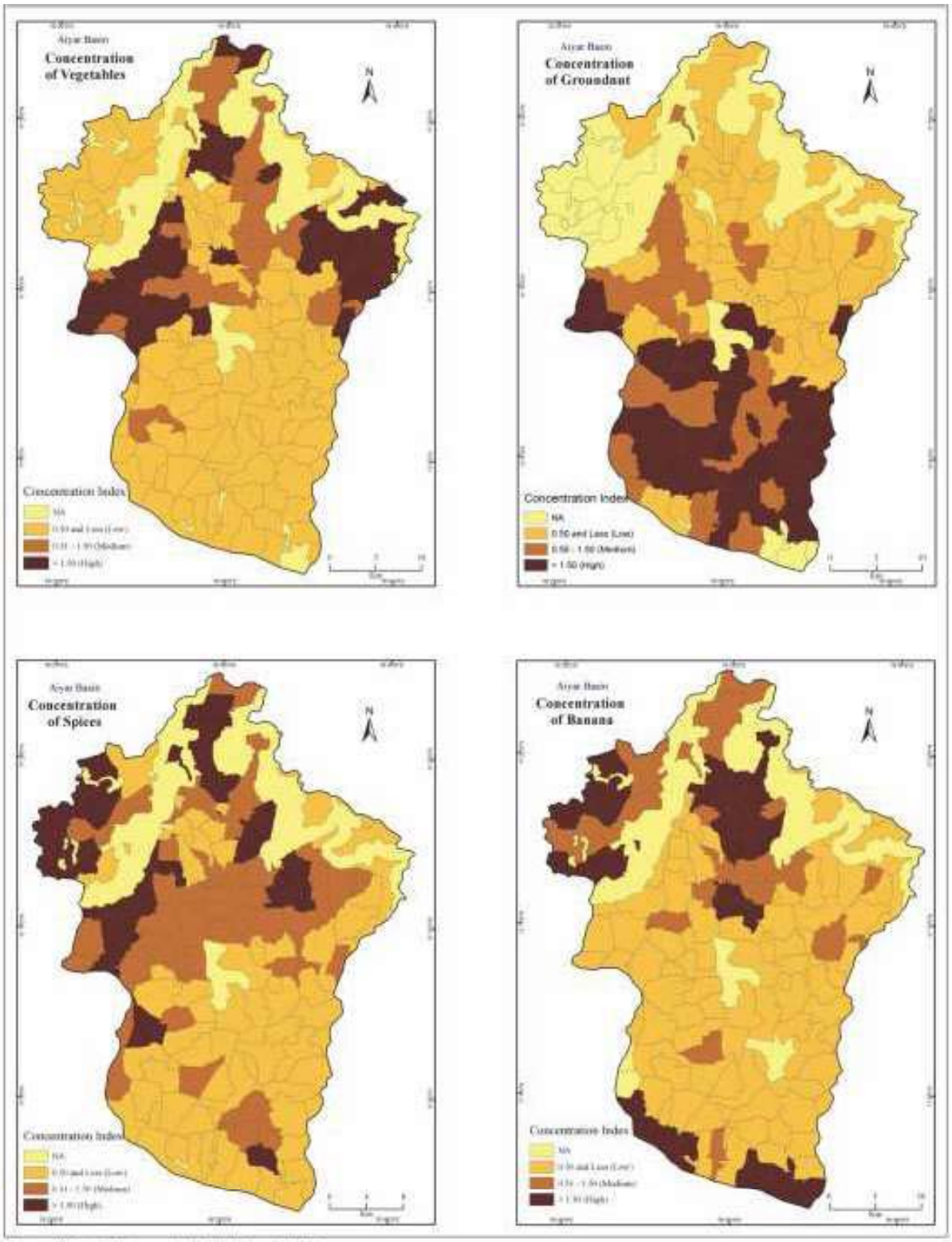
The high concentration of maize occurs mainly in the north-eastern parts of the basin. It is an important dry crop of this region claiming over 5 per cent of the total cropland of the basin. Kolli hills and floodplain regions of the study area are marked with low concentration of maize (Fig. 6).

(x) Cotton

Similar to maize, high concentration of cotton is mostly found in the north-eastern parts of the basin. Hence, maize and cotton seems to be spatially associated (Fig. 6). Not only do their areas of concentration overlap but one or the other occupies first or second position in area under these crops. Soil of this region is very much suitable for these two crops.

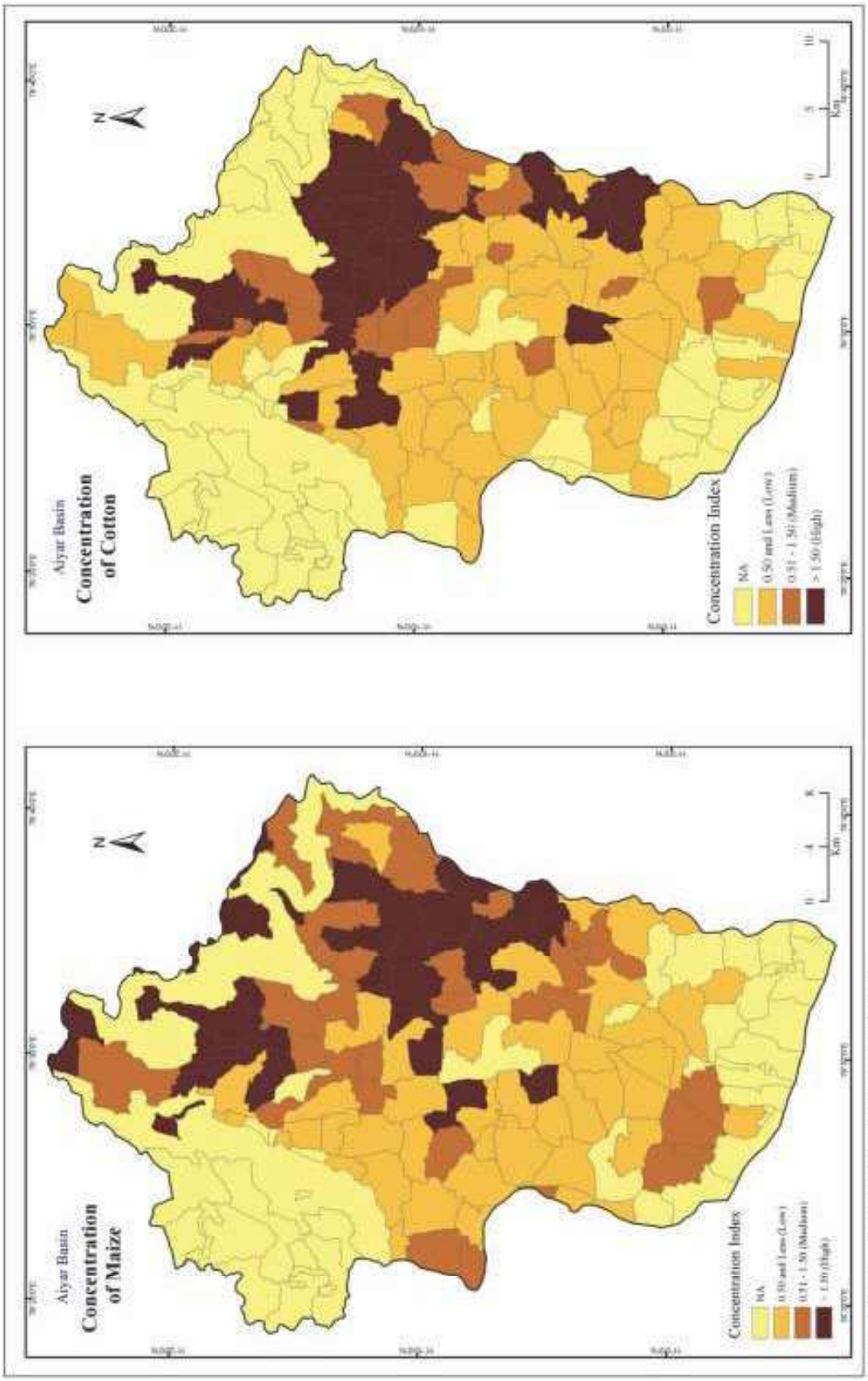
Patterns of Crop Diversification

A variety of crops are cultivated over the entire basin, as the farmers tend to grow various crops for different reasons. In general, the relative profitability of crops, changes in technology, expansion of irrigation and possibility of improvement in productivity are the major factors which encourage diversification of crops in the basin. Therefore, the crops grown in the basin, share only a small proportion of net sown area. It is observed that even the first ranking crop in many villages



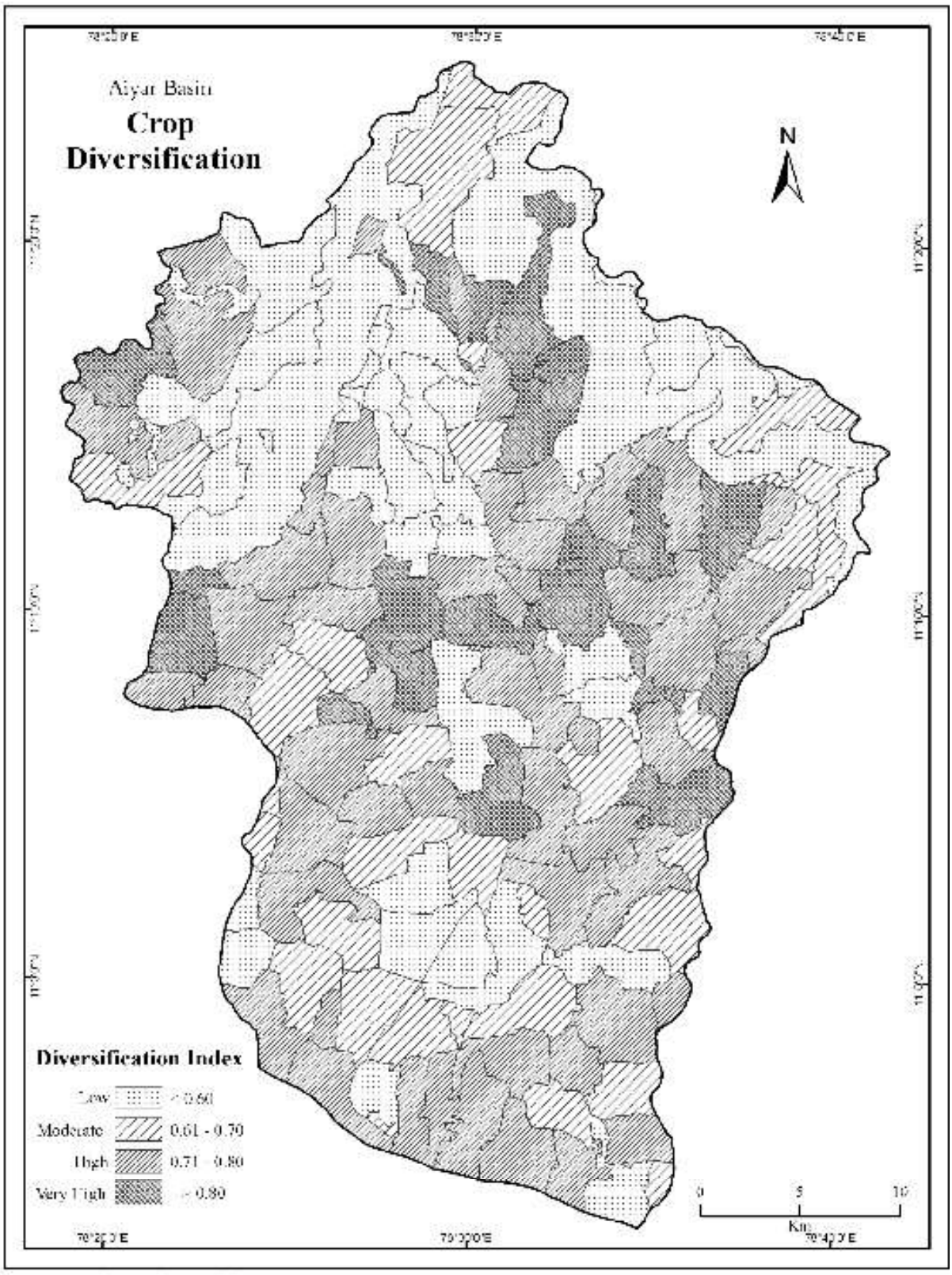
Source: Dept. of Economics & Statistics, GoTN

Fig. 5



Source: Dept. of Economics & Statistics, GoTN

Fig. 6



Source: Dept. of Economics & Statistics, GoTN

Fig. 7

occupy as low as 25 per cent of the net sown area. However, the extent and rate of crop diversification is varying from one village to another.

The index values obtained for each village have been sorted and quartiles were determined to distinguish four classes of crop diversification such as low (0.60 and less), moderate (0.61-0.70), high (0.71-0.80) and very high (>0.80). The spatial variations in the degree of crop diversification in the basin, corresponding to the above index, are shown in Fig.7.

The diversification index of 0.88 obtained for the basin as a whole suggests a very high crop diversification in the basin. The areas with low diversification of crops lie in northern uplands and along the main river valleys as well as over the southern pediments. These areas seem to coincide with the areas of paddy, sorghum or tapioca dominance zones. Since, the river valleys of the basin have fertile soils and good groundwater potential, most of the farmers in these parts prefer paddy cultivation. In contrast, sorghum and tapioca are preferred in the southern pediments and northern uplands because of the absence of adequate plain land and irrigation facilities. The areas of very high crop diversification are confined to foothill region, especially in north-eastern foothills. It has been found that in areas of high crop diversification, the leading crop occupied a small proportion of net sown area. It happened, because due to favorable agronomical conditions, multiple copping was possible in the study region.

Conclusions

The indices of crop concentration and diversification offer a catalyst to understand the complexities of crop distributions in a quantitative manner. Although the study area has a wide variety of crops, yet about 75 per cent of the basin is under cultivation, of six major crops of paddy, sorghum, tapioca, pulses, vegetables and groundnut. However, concentrations of these crops create a spatially differentiated scenario in agricultural development of the basin. The high diversification of crops is prevalent throughout the basin except in the areas predominately under paddy, sorghum and tapioca. The study highlights that the patterns of crop concentration and diversification in the study area are mostly controlled by topography, soil fertility, rainfall and irrigation facilities. The spatial variations of cropping pattern identified in the study area are highly useful to agricultural and land use planners. Nevertheless, the evaluation of crop pattern cannot be completed without considering yield of various crops, productivity effects and socio-economic conditions. Further, it is also indispensable to study the seasonal pattern of rainfall and its vagaries, soil erosion and depletion of groundwater resources which also contribute a greater extent to regional variations in agricultural practices of the study area.

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M. Gomathi, UGC BSR Research Fellow

Dr. K. Kumaraswamy, UGC BSR Faculty Fellow
Email: kkumargeo@gmail.com
(Author for Correspondence)
Department of Geography,
Bharathidasan University,
Tiruchirappalli