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Changes in the Land Use Pattern and Cropping Pattern among Different Gradients of Tiruchirapalli District – A Farm Level Analysis

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Agriculture plays a vital role in an Indian Economy. Changes in land use subsequently leading to decreased agricultural land in favour of the provision of residential accommodation in most urban settlements. The extent of land use is also influenced by technological changes over a period of time. The technological changes in agriculture ignited intensive cultivation resulting in conversion of marginal lands into productive agricultural lands through capital intensive cultivation. Changes in farming and land use patterns result in urbanisation, which puts ecological stability and food security at risk. Within this background, the study has been formulated with the objectives of land use pattern and cropping pattern is to analyse the temporal changes in the land use pattern and the loss of agricultural land in the selected rural, peri-urban and urban gradients, to study the changes and shift in cropping pattern and to estimate the crop diversification across the gradients. A

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multistage stratified random sampling technique was used. The data has been analysed using descriptive statistics, diversification indices, multiple regression analysis and garett ranking. The results of farm level analysis revealed that the conversion of the agricultural land through human settlements and other uses was more pronounced in the urban and peri-urban households than the rural households, might be due to urbanization and industrialization. The results also revealed that the gradual shift in the cropping pattern was pronounced in the rural gradient, followed by peri-urban and urban gradients. The major constraint faced by the sample respondents were water scarcity and labour scarcity for the land use and crop diversification.

Keywords: Land use; cropping pattern; households; gradients; farm level analysis.

1. INTRODUCTION

Agriculture plays a vital role in Indian economy. Changes in land use subsequently lead to decreased agricultural land in favour of the provision of residential accommodation in most urban settlements. Land use pattern has been defined as the utilisation of land for various purposes, as stated in the nine-fold classification of land use. According to Ahmed et al., [1], land use is referred as the reflection of human activities, such as the use of the land like industrial zones, residential zones, agricultural fields, etc. Cropping pattern has been defined as the proportion of area under major crop categories at a particular point of time in a particular area and according to Gupta and Singh [2], cropping pattern is a dynamic entity and it keeps on changing in any country, state or region in consonance with the changes in agricultural prices, government policies and other related factors.

Dynamics of land use is a complex phenomenon, which is affected by several socio-economic, agro-climatic and ecological variables. Both climatic and institutional factors are crucial in determining land use pattern. The extent of land use is also influenced by technological changes over a period of time. The technological changes in agriculture ignited intensive cultivation resulting in conversion of marginal lands into productive agricultural lands through capital intensive cultivation [3,4].

Consequently, the pattern of land use in urban areas characterize the collective effects of innumerable decisions and procedures by individuals and institutions. Changes in land uses have a number of ecological impacts affecting both urban and rural areas. Most prominent land use dynamics are the land conversion that happens in the urban fringe of big cities under various economic and demographic factors [5].

The population is expanding today, which has led to a rise in the demand for food. Changes in cropping pattern and land use patterns result in urbanisation, which puts ecological stability and food security at risk. Within this background, the specific objectives set forth for the study are,

1. To analyse the temporal changes in the land use pattern and the loss of agricultural land in the selected rural, peri-urban and urban gradients.
2. To study the changes and shift in cropping pattern and to estimate the crop diversification across the gradients.

2. DESCRIPTION OF STUDY AREA

Tiruchirapalli District is one of the oldest inhabited districts in Tamil Nadu. Among 38 districts of Tamil Nadu, the district is centrally located in the state. The district has an area of 4403.83 sq. km stretching between 10.7905° N 78.7047°E and the altitude is 81m above sea level. The district is bordered by Perambalur district in the north side, the districts Thanjavur and Pudukkottai in the eastern side, the districts Sivaganga, Madurai and Dindugal in the southern side and Karur district in the western side.

3. DESIGN OF THE STUDY

3.1 Methodology

A multistage stratified random sampling technique with Tiruchirapalli district as the universe, the taluks as the first stage unit, the different gradients in the taluks as the second

stage unit, the villages in the taluks as the third stage unit and the households as the fourth and ultimate unit of sampling, was adopted in this study.

The nine taluks of Tiruchirapalli district have been classified as three gradients namely, Rural, Peri-urban and Urban, based on the proportion of urban population in the respective taluks (Census 2011) and also by referring geographical map of Tiruchirapalli district. In the first stage of sampling, one taluk has been randomly selected from each of the gradients six villages have been randomly selected from each of the selected gradient and 15 respondents have been randomly selected from each of three villages. The ultimate sample consists of 270 sample respondents, which comprised of 90 sample respondents in each of the gradients, namely, Rural, Peri-urban and Urban. The primary data has been collected from the sample respondents of Rural, Peri-urban and Urban gradients using structured interview schedule.

3.2 Tools of Analysis

3.2.1 Descriptive analysis

Descriptive statistical analysis was undertaken using percentage, mean etc. to study the household characteristics of the sample respondents and in other analyses wherever necessary.

3.2.2 Multiple regression model

Multiple regression model was also employed to study the relationship between two or more explanatory variables and a response variable by fitting an equation. Every value of the independent variable is associated with values of the dependent variable. R^2 indicates the proportion of variation in dependent variable accounted for by the set of independent variables.

i) Factors Influencing Land Values: Multiple regression function was carried out to identify the factors influencing land values in the three different gradients, *viz.,* rural, peri-urban and urban. The functional form used was,

$$Y_r = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \mu$$

Where,

Y = Sale value of land (Rupees)
X_1 = Size of land holding (acre)
X_2 = Distance to city (kms)
X_3 = Good business environment (binary)
X_4 = Infrastructure development (binary)
β_i's = Parameters to be estimated
μ_i = error term

ii) Factors Influencing Crop Diversification: A linear regression model was employed to examine the factors influencing crop diversification in the study area, through the following equation.

$$Y_r = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mu$$

Where,

Y_t = Household crop richness index
α = Constant
X_1 = Size of land holdings (acres)
X_2 = Household income (Rs.)
X_3 = Gross irrigated area (acres)
β_i's = Parameters to be estimated
μ = Error term

3.2.3 Diversification indices

There are quite a few methods, which explain either concentration (i.e. specialization) or diversification of crops or activities in a given time and space. Each method has some limitations and/or superiority over the others. The following indices were used in the study to measure the extent of diversification.

Herfindahl Index (HI): Herfindahl Index is the sum of square of the acreage proportion of each crop in the total cropped area. The index is computed as

$$H = \sum_{i=1}^{N} P_i^2 \quad ,$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

Simpson Index (SI): The Simpson Index (SI) is the most suitable index of measuring diversification in a particular geographical region. Mathematically, SI is defined as

$$SI = 1 - \sum_{i=1}^{N} P_i^2 \quad ,$$

where, $P_i = A_i / \Sigma A_i$ is the proportion of the i^{th} crop in acreage.

Entropy Index (EI): The Entropy Index is a direct measure of diversification having a logarithmic character. The index is computed as:

$$E = \sum_{i=1}^{N} P_i^2 * \log (1/P_i)$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

3.2.4 Garrett ranking technique

In this study, Garrett ranking technique was used to rank the constraints faced in land use and crop diversification.

As a first step, the per cent position of each rank was found out by the following formula:

$$\text{Per cent position} = \frac{100\ (R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = Rank given to the i^{th} item by the j^{th} individual
N_j= Number of items ranked by the j^{th} individual

4. RESULTS AND DISCUSSION

4.1 Land Holding Pattern of the Sample Households

The distribution of sample households according to the size of land holdings was analysed and the results are furnished in Table 1.

It could be seen from Table 1 that majority of the rural and urban households were having small land holdings (below 2.5 acres), which constituted 51.11 per cent and 43.33 per cent, respectively, followed by 36.67 per cent of rural households and 30 per cent of the urban households possessed medium size of land holding. Only, 5.56 per cent of the rural households and 10 per cent of the urban households were large land holders.

However, majority of the peri-urban households (45.56 per cent) possessed medium size of land holdings, followed by small holdings (31.11 per cent) and large holdings (11.11 per cent). However, the respondents with landlessness constituted a major share of 16.67 per cent in urban households, 12.22 per cent in the peri-urban households and only 6.66 per cent in the rural households.

It could be concluded that majority of the sample households in all the three gradients were either small farmers or marginal farmers. Also, the landlessness was seen more in the urban households than in the peri-urban and rural households.

4.2 Average Annual Income of the Sample Houeholds

Income of the households also explains the economic background and hence forms an important aspect on the influence of urbanisation. Hence, the income from different sources, viz., on-farm, off-farm and non-farm was collected and presented in the Table 2.

The results revealed that the average annual income of the urban households was Rs.2,17,587/, which was comparatively higher than that of the peri-urban and rural households (Rs.1,78,690/- and Rs.88,487/-, respectively). It is also seen that in the rural gradient, a major share of income was received from on-farm activities (36.54 per cent), followed by off-farm activities (32.72 per cent) and only 30.74 per cent of income was earned from the non-farm activities. Whereas, in the peri-urban and urban households, major share of income was obtained from non-farm activities (50.99 per cent and 53.02 per cent,) followed by off- farm activities (29.70 per cent and 30.59 per cent) and on-farm activities (19.32 per cent and 16.39 per cent), respectively. The urban and peri-urban households received an additional income of Rs.88,177/- and Rs.63,911/- from non-farm activities and the additional income from on-farm activities were only Rs.3,320/- and Rs.2,185/- over rural households.

4.3 Land Utilization Pattern of the Sample Households

The land utilization pattern of the rural, peri-urban and urban sample households in the study area has been analysed by taking three land uses namely, net area sown, land put to non-agricultural uses and fallow lands over a period of five years (2015-20) and the results are presented in Table 3.

Table 1. Land holding pattern of the sample households

(in Numbers)

S. No	Size of Land Holdings	Rural	Peri-urban	Urban
1.	Small (below 2.5 acres)	46 (51.11)	28 (31.11)	39 (43.33)
2.	Medium (2.5-5 acres)	33 (36.67)	41 (45.56)	27 (30.00)
3.	Large (above 5 acres)	5 (5.56)	10 (11.11)	9 (10.00)
4.	Landlessness	6 (6.66)	11 (12.22)	15 (16.67)
	Total	90 (100)	90 (100.00)	90 (100.00)

Note: Figures in the parentheses indicate percentages to the respective totals

Table 2. **Average annual income of the sample houeholds**

S. No	Economic Indicators	Rural	Peri-urban	Increment	Urban	Increment
III.	**Annual Income (in Rupees)**					
1.	On-farm	32,332 (36.54)	34,517 (19.32)	2,185 (6.76)	35,652 (16.39)	3,320 (10.27)
2.	Off-farm	28,957 (32.72)	53,064 (29.70)	24,107 (83.25)	66,560 (30.59)	37,603 (129.86)
3.	Non-farm	27,198 (30.74)	91,109 (50.99)	63,911 (234.98)	1,15,375 (53.02)	88,177 (324.20)
	Total	88,487 (100)	1,78,690 (100)	90,203 (101.94)	2,17,587 (100)	1,29,100 (145.90)

It could be seen from the table that in the rural households, the net sown area has decreased from 62.96 per cent in 2015-16 to 54.91 per cent in 2019-20 with a percentage change of -14.51. Whereas, the land put to non-agricultural uses has increased from 13.58 per cent to 18.14 per cent between the two periods and recorded a change of 30.91 per cent. The fallow lands have also been marginally increased from 23.46 per cent to 26.95 per cent with a percentage change of 12.63.

The same pattern has been noticed in the peri-urban and urban households, wherein, the net area sown has been decreased by 14.41 per cent and 18.43 per cent, respectively, between 2015-16 and 2019-20. Whereas, the land put to non-agricultural uses has increased by 49.15 per cent and 48.53 per cent, respectively, in peri-urban and urban gradients. The percentage changes recorded for fallow lands were 17.27 per cent and 41.96 per cent for the peri-urban and the urban gradients, respectively. However, the rate of decline in the net area sown was more in the urban households as compared to rural and peri-urban gradients, thus indicating the shift in the land use for non-agricultural purposes. It could be concluded the utilisation of agricultural land for urban uses had increased in the recent years.

4.4 Conversion of Land

The conversion of land uses by the sample respondents of the three gradients, through human settlements and other land uses due to the effect of urbanization were studied and the results are presented in Table 4 and Fig. 1.

From Table 4 it could be revealed that a large majority of the sample respondents reported that the land has been converted as built-up area, i.e., around 65 per cent in the rural households, 72 per cent in the peri-urban households and 86 per cent in the urban households. Also, majority of the sample respondents reported that the land has been converted as fallow land, i.e., around 54 per cent in the rural households, 63 per cent in the peri-urban and 78 per cent in the urban households.

The majority of the respondents reported that the land has been kept as barren, which constituted 45 per cent in the rural, 62 per cent in the peri-urban and 42 per cent in the urban households. And the land put for sale purpose was reported by around 71 per cent of the peri-urban households, 61 per cent of the urban households and only 35 per cent of the rural households [6-10].

Table 3. Land utilization pattern of the sample households

(in acres)

S.No	Land Use Categories	Rural 2015-16	2017-18	2019-20	Percentage Change	Peri-urban 2015-16	2017-18	2019-20	Percentage Change	Urban 2015-16	2017-18	2019-20	Percentage Change
1.	Net area sown	255 (62.96)	228 (58.16)	218 (54.91)	-14.51	222 (56.78)	207 (52.40)	190 (45.56)	-14.41	217 (54.66)	205 (49.04)	177 (40.50)	-18.43
2.	Land put to non-agricultural uses	55 (13.58)	64 (16.33)	72 (18.14)	30.91	59 (15.09)	62 (15.70)	98 (23.50)	49.15	68 (17.13)	78 (18.66)	101 (23.11)	48.53
3.	Fallow lands	95 (23.46)	100 (25.51)	107 (26.95)	12.63	110 (28.13)	126 (31.90)	129 (30.94)	17.37	112 (28.21)	135 (32.30)	159 (36.38)	41.96
	Total	405 (100.00)	392 (100.00)	397 (100.00)	-1.98	391 (100.00)	395 (100.00)	417 (100.00)	23.64	397 (100.00)	418 (100.00)	437 (100.00)	10.08

Note: Figures in the parentheses indicate percentage to the respective total

Table 4. Conversion of land by the sample respondents

S. No	Land Uses	Rural Yes	No	Area (in acres)	Peri-urban Yes	No	Area (in acres)	Urban Yes	No	Area (in acres)
1.	Built-up area	59 (65.56)	31 (34.44)	22	65 (72.22)	25 (27.78)	31	78 (86.67)	12 (13.34)	39
2.	Fallow land	49 (54.44)	41 (45.56)	107	57 (63.33)	33 (36.67)	129	71 (78.89)	19 (21.11)	159
3.	Barren land	41 (45.56)	49 (54.44)	11	56 (62.22)	34 (37.78)	13	38 (42.22)	52 (57.78)	15
4.	Sales purpose	32 (35.56)	58 (64.44)	50	64 (71.11)	26 (28.89)	67	55 (61.11)	35 (38.89)	62

Note: Figures in the parentheses indicates percentage to respective total

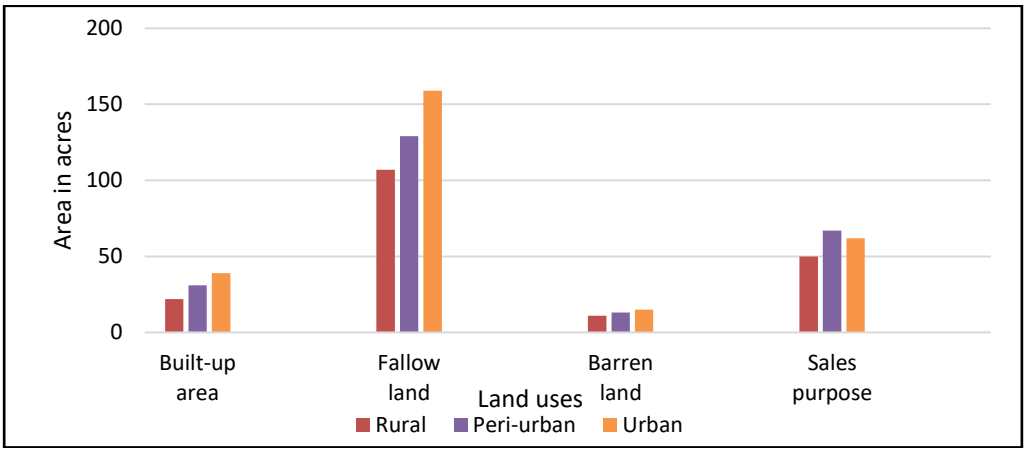

Fig. 1. Conversion of land by the sample respondents

The results also revealed that the land area converted as built-up area accounted for 39 acres in the urban gradient, which was the highest, followed by 31 acres in the peri-urban gradient and only 22 acres in the rural gradient. The same trend has been noticed in the conversion of land into fallow and barren land, which were 159 acres and 15 acres in the urban gradient, followed by 129 acres and 13 acres in the peri-urban gradient and 107 acres and 11 acres in the rural gradient, respectively.

However, the area kept for sales purpose was accounted for 67 acres in the peri-urban gradient, which was comparatively higher than the urban gradient (62 acres) and the rural gradient (50 acres). This might be due to the higher land values prevailing in the peri-urban areas because of the ongoing highways project in Manachanallur taluk.

It was also noticed that there has been a rapid conversion of large amount of prime agricultural land through urban land uses, mostly residential construction, in the urban periphery. This clearly indicated that the conversion of agricultural land was more pronounced in the urban and peri-urban households, might be due to urbanization and industrialization.

4.5 Purpose wise Leasing of Land

The leasing of farm lands for agriculture as well as for non-agricultural purposes was common across the gradients. Hence, purpose-wise leasing of land has been analysed and the results are presented in Table 5.

It could be observed from Table 5 that the average rent paid per acre of the leased in farm lands, which have been used for agricultural purposes were lower at Rs.3,550/-in the rural gradient, Rs.4,725/- in the peri-urban gradient and Rs.4,579/- in the urban gradient than the rent paid for leased in land used for non-agricultural purposes, i.e., Rs.4,238/-, Rs.5,610/- and Rs.6,723/, respectively, for the three gradients.

In the same way, the average rent for leased out lands that have been used for agricultural purposes in all the three gradients were found to be lower than the rent for leased out land for non-agricultural purposes. They accounted for Rs.6,732/-, Rs.7,552/- and Rs.7,618/- for rural to urban gradients for agricultural purpose and Rs.8,218/-, Rs.10,124/- and Rs.12,350/- for non-agricultural purposes, respectively, for the three gradients.

It could also be seen that the area leased in for agricultural purposes was higher in the rural gradient (163 acres), than the peri-urban (158 acres) and the urban gradients (152 acres), while the land leased in for non-agricultural purposes was higher in the urban and peri-urban gradients.

With regard to leased out land, the urban household had leased out 141 and 152 acres of land, which was higher than the other two gradients, *viz.,* peri-urban (130 and 147 acres) and rural (127 and 141 acres). The prevalence of lower rent for leased in land compared to leased out land, might be due to the changes in the cultivation pattern of crops in the study area. It

was gathered from the survey that the leased in land have been mostly used for raising crops like paddy and pulses, while sugarcane has been cultivated in the leased out lands, which is a cash crop. The result clearly indicates that the rental value for the land used for non-agricultural purposes was higher than for agricultural purposes.

4.6 Land Values in the Sample Gradients

Land values depend on the accessibility to nearby land uses like infrastructure and built-up environment. Land prices rise when the demand for land exceeds the availability of land or inherent value of a piece of land exceeds that in the adjacent areas. The land values have been increased during recent years due to population pressure and urbanization. The information on land values as specified by the respondents were analysed and the results are presented in Table 6 and Fig. 2.

It is evident from the table that the value of land in all the three gradients had a sharp increase over the ten-year period. It is almost four times than the value prevailed in 2010. However, the land values in the urban settings have fetched a higher value in 2010 and 2015, as compared to peri-urban and rural settings. Whereas, the land values were the highest in the peri-urban gradient in 2019, when compared to rural and urban settings, might be due to the development of infrastructures in the region, such as outer ring roads project in the district and highways construction in Manachanallur taluk to the other districts, such as Erode, Salem, etc.

4.7 Factors Influencing the Land Values in the Study Area

The factors influencing the land values in the study area were identified using a multiple regression analysis, wherein the sale value of land (per acre) was regressed on the factors like, size of land holding (acre), distance to city (kms), good business environment (binary) and infrastructure development (binary). The results are presented in Table 7.

The coefficient of multiple determination (R^2 = 0.71, 0.78 and 0.73) revealed that 71 per cent, 78 per cent and 73 per cent of variation in the land values was explained by the included variables in the model and F value indicates the best fit of regression.

Table 5. Purpose wise leasing of land with their values

S. No	Purpose of Lease	Rural		Peri-urban		Urban	
		Area (in acres)	Value (Rs. /acre)	Area (in acres)	Value (Rs. /acre)	Area (in acres)	Value (Rs. /acre)
1.	**Leased in**						
	Agricultural purposes	163	3,550	158	4,725	152	4,579
	Non-agricultural purposes	104	4,238	181	5,610	180	6,723
2.	**Leased out**						
	Agricultural purposes	127	6,732	130	7,552	141	7,618
	Non-agricultural purposes	141	8,218	147	10,124	152	12,350

Table 6. Land values in the sample gradients

(Rs./ acre)

S. No	Gradients	2010	2015	Percentage change over 2010	2019	Percentage change over 2019
1.	Rural	3,50,728	6,78,152	93.35	11,12,537	217.21
2.	Peri-urban	5,20,175	10,23,752	96.81	30,52,103	486.75
3.	Urban	7,25,631	15,00,278	106.75	25,21,381	247.47

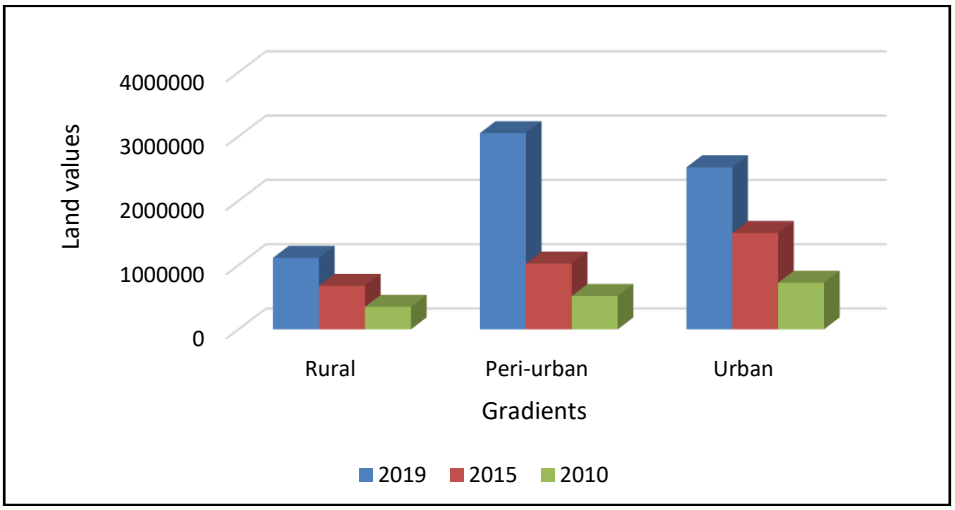

Fig. 2. Land Values in the Sample Taluks

Table 7. Estimates of the factors influencing the land values in the study area

S. No	Variables	Rural	Peri-urban	Urban
1.	Constant	27.653 (2.198)	33.521 (3.935)	35.786 (5.397)
2.	Size of holdings (acres)	0.095 (0.072)	0.106 (0.185)	1.216 (0.231)
3.	Distance to city (Kms)	0.213 (0.107)	-0.079** (0.042)	-0.058** (0.006)
4.	Good business environment (binary)	0.325*** (0.001)	0.623** (0.015)	0.534** (0.023)
5.	Infrastructure development (binary)	0.927 (0.003)	0.117*** (0.002)	0.025*** (0.009)
	R^2 F values	0.71 45.82	0.78 44.41	0.73 46.23

Note: Figures in the parentheses are p-values
*(** and *** indicate significance at 5 per cent and 1 per cent levels, respectively)*

In the rural gradient, the coefficient of the variable, good business environment was found to have a significant positive impact on the land value, implying that if the business environment is good, the land value would increase by 0.325 times.

In the peri-urban gradient, the coefficient of the variables, distance to city, good business environment and infrastructure development were found to be significant and would influence the land values. For every unit increases in the distance to city would decrease the land value by 0.079 times. And every increase in responses to good business environment and infrastructure development would increase the land value by 0.623 and 0.117 times, respectively.

In the urban gradient, the results were similar to the results obtained in the peri-urban gradient. The same variables, distance to city, good business environment and infrastructure development were found to be significant. The land value decreases with every km increase in the distance to city.

It could be concluded that the variables, distance to city, good business environment and infrastructure development were significant with the expected signs. These were the most influencing variables predicted in the model for

the variation in land values across the study area [11-14].

4.8 Cropping Pattern of the Sample Households

The changes in the cropping pattern of the sample households have been worked out for the crops grown in three periods, *viz*., 2015-16, 2017-18 and 2019-20 to capture the changes in the cropping pattern among the three gradients of the sample households and the results are presented in Table 8. It was observed from the survey that farmers in the study area were growing paddy, sugarcane, banana, pulses, cotton and vegetables over a long period of time.

It could be seen from Table 8 that among the rural households, the share in the area under cotton and banana, which are the major crops in this area, has increased from 20.39 per cent and 20.78 per cent in 2015-16 to 27.98 per cent and 27.52 per cent in 2019-20, thus recorded with percentage changes of 17.31 and 13.21, respectively. The percentage change in the area under paddy was21.57 per cent. However, the area under pulses, sugarcane and vegetables have decreased by62.50 per cent, 65.95 per cent and 6.50 per cent, respectively.

The major crop cultivated by the peri-urban and urban households was paddy and the proportion of paddy area has substantially increased from 24.77 per cent and 30.88 per cent to 33.16 per cent and 67.23 per cent, respectively, over a period of five years, with a percentage change of 14.54 and 77.61. The area under other crops in the urban gradient have declined and also occupied low share in the total cropped area.

From the above discussions, it is understood that the urban households still had a major share of area under paddy crop, followed by peri urban and rural households. It could be concluded that gradual shift in the cropping pattern was comparatively higher in the rural gradient. This might be due to the fact that the sample rural farmers are mostly engaged in agriculture and allied activities and depend mainly on agriculture for their livelihood, which forced them to diversify their crop activities to some extent.

4.9 Farm Level Crop Diversification

An attempt has been made to analyse crop diversification at the farm level based on the crops grown by the three gradients of sample households in the study area. The major crops cultivated by rural gradient were paddy, banana, cotton, sugarcane, bhendi and brinjal, whereas in the peri-urban gradient, the major crops grown were paddy, banana, sugarcane, cotton and brinjal and in the urban gradient, paddy, pulses and sugarcane were grown. The results of crop diversification indices are presented in Table 9.

From Table 9, it was observed that the Simpson and Entropy indices have higher values in the sample rural households (0.67 and 0.98), followed by the peri-urban households (0.63 and 0.96) and urban households (0.61 and 0.92), whereas the Herfindahl index showed a lower value in the rural households (0.34), followed by peri-urban households (0.37) and urban households (0.39). The results imply that the crop diversification was comparatively higher in the rural gradient than in the peri-urban and urban gradients. It could be understood during the survey that the sample rural farmers cultivated a maximum of six crops and the peri-urban farmers cultivated five crops and the urban farmers raised three crops. On an average, each household maintained about three crops in the rural gradient, about one to two crops in the peri-urban and urban gradients, which reveals the prevalence of crop diversification at the farm level also to some extent.

4.10 Factors Influencing Crop Diversification in the Sample Households

The factors influencing crop diversification in the study area were identified for the three gradients of the sample households using regression analysis, wherein the crop richness was regressed on the factors like size of holding, household income and gross irrigated area (as a linear measure for extent of irrigation). The results are presented in Table 10.

It could be seen from Table 10 that in the sample rural households, the coefficient of multiple determination (R^2=0.84) revealed that 84 per cent of the variation in the crop diversification was explained by the included variables in the model and F value indicates the best fit of the regression. All the variables, *viz*., size of land holding, family income and area irrigated were found to have positive effect on crop diversification.

Table 8. Cropping pattern of the sample households

(in acres)

S.No.	Crops	Rural			Percentage	Peri-urban			Percentage	Urban			Percentage
		2015-16	2017-18	2019-20	Change	2015-16	2017-18	2019-20	Change	2015-16	2017-18	2019-20	Change
1.	Paddy	51 (20.00)	57 (25.00)	62 (28.44)	21.57	55 (24.77)	59 (28.50)	63 (33.16)	14.54	67 (30.88)	117 (57.07)	119 (67.23)	77.61
2.	Pulses	32 (12.54)	21 (9.21)	12 (5.50)	-62.5	21 (9.46)	18 (8.69)	12 (6.32)	-42.86	39 (17.97)	20 (9.76)	13 (7.34)	-66.67
3.	Sugarcane	47 (18.43)	22 (9.65)	16 (7.33)	-65.95	33 (14.86)	21 (10.14)	9 (4.74)	-72.72	28 (12.90)	17 (8.29)	11 (6.21)	-60.71
4.	Cotton	52 (20.31)	59 (25.88)	61 (27.98)	17.31	49 (22.07)	51 (24.64)	52 (27.37)	6.12	24 (11.06)	12 (5.85)	9 (5.08)	-62.50
5.	Banana	53 (20.78)	58 (25.44)	60 (27.52)	13.21	45 (20.27)	49 (23.67)	49 (25.79)	8.88	27 (12.44)	15 (7.32)	10 (5.65)	-62.96
6.	Vegetables	20 (7.84)	11 (4.82)	7 (3.21)	-6.50	19 (8.56)	9 (4.35)	5 (2.63)	-73.68	32 (14.75)	24 (11.71)	15 (8.47)	-53.12
	Total	255 (100.00)	228 (100.00)	218 (100.00)	-14.51	222 (100.00)	207 (100.00)	190 (100.00)	-14.41	217 (100.00)	205 (100.00)	177 (100.00)	-18.43

Note: Figures in the parentheses indicate percentage to respective total

Table 9. Crop diversification indices for the sample households

S. No	Indices	Rural	Peri-urban	Urban
1.	Herfindahl index (HH)	0.34	0.37	0.39
2.	Simpson index (HH)	0.67	0.63	0.61
3.	Entropy index (HH)	0.98	0.96	0.92
4.	Crop richness (Study Area)	6	5	3
5.	Household crop richness	3.25	2.42	1.75

*(** and *** indicate significance at 5 per cent and 1 per cent levels, respectively)*

Table 10. Factors influencing crop diversification in the sample households

S. No	Variables	Rural		Peri-urban		Urban	
		Coefficients	P values	Coefficients	P values	Coefficients	P values
1.	Constant	9.875	0.205	11.623	0.109	8.325	0.124
2.	Size of holding (acres)	0.102**	0.023	0.207**	0.036	0.112**	0.045
3.	Household income (Rs.)	0.023***	0.004	0.031***	0.007	0.055**	0.021
4.	Gross irrigated area (acres)	0.341**	0.042	0.075***	0.002	0.204***	0.003
	R^2	0.84		0.83		0.85	
	F values	48.54		42.96		44.67	

*(**and*** indicate significance at 5 per cent and 1 per cent levels, respectively)*

The coefficient for the variable, size of holding was 0.102, indicating that for every one acre increase in the size of holding, the crop richness would increase by 0.102 times. The income of the family was also a variable with a significant coefficient, implying that every one rupee increase in the family income, would increase the crop richness by 0.023 times. So also, the variable gross irrigated area indicates that for increase in the area irrigated by an acre, the crop richness would increase by 0.341 times.

In the peri-urban households, the coefficient of multiple determination (R^2 = 0.83) revealed that 83 per cent of variation in the crop diversification was explained by the included variable in the model and F value indicated the best fit for regression. All the variables included in the model were positively significant for crop diversification. The coefficient for size of land holding indicates that for every one acre increase in the land holding, the crop richness increases by 0.207 times. The household income and gross irrigated area were also significant, which implies that every unit increase in these variables would increase the crop richness by 0.031 times and 0.075 times, respectively.

In the urban households also 85 per cent variation in the crop diversification was explained by the included variables and all the variables included in the model were positively significant. The variables, size of land holding, income of the family and gross irrigated area indicates that for every one unit increase in these variables would increase the crop richness by 0.112, 0.055 and 0.204 times, respectively.

Hence, it could be concluded that the crop diversification has been influenced mainly by size of land holding, household income and gross irrigated area.

4.11 Constraints in Land Use and Crop Diversification

The major constraints faced by the sample households in the diversification of land use and crop categories at farm level were captured using Garrett ranking technique. Since the ranking

Table 11. Constraints in land use and crop diversification in the sample households

S. No	Constraints	Mean Score	Rank
1.	Water scarcity	95.60	I
2.	Labour scarcity	92.17	II
3.	Increase in input prices	86.95	III
4.	Low on-farm income	81.07	IV
5.,	Yield risk	79.72	V
6.	Price risk	75.03	VI
7.	Lack of storage facility in villages	65.79	VII
8.	Lack of access to markets	61.38	VIII
9.	Environmental factors	56.99	IX

given by the respondents in all the three gradients showed no significant difference between the gradients, the Garrett ranking was done for the sample as a whole. The results are presented in Table 11.

The water scarcity was ranked as the major constraint influencing the land use and crop diversification, as the farmers face failure of monsoon often. The labour unavailability was the second most important constraint responsible for the land use and crop diversification. The farmers opined that increase in the input prices such as prices of fertilizers, labour wages and other expenses could not be met out from the low income realized from agriculture. Hence, these constraints were ranked as third and fourth position in the land use and crop diversification. Yield risk and price risk, were ranked as fifth and sixth, mainly due to lack of technologies, inflation and high transport charges of commodities.

Lack of storage facility in the villages (Godowns) and lack of access to markets were the important problems faced by the farmers, as the rural godowns would be useful for farmers to store their products from pest attack or spoilage and to sell these products when market prices are high. These factors were responsible for land use and crop diversification, which was ranked as seventh and eighth position. Finally, environmental factors such as drought, flooding, cyclones etc., were also responsible for the land use and crop diversification.

5. SUMMARY AND CONCLUSION

Majority of the sample households in all the three gradients were either small farmers or marginal farmers. The rate of increase in the land put to non-agricultural uses was the highest in the peri-urban gradient, followed by urban and rural gradients. However, the rate of decline in the net area sown was more in the urban households as compared to rural and peri-urban gradients, which indicated that the utilisation of agricultural land for urban uses had increased in the recent years. The conversion of the agricultural land through human settlements and other uses was more pronounced in the urban and peri-urban households than the rural households, might be due to urbanization and industrialization. Also, the increase in the land values was higher in the peri-urban gradient than the urban and rural gradients. The variables, distance to city, good business environment and infrastructure development were the most influencing variables predicted in the model for the variation in land values across the study area.

The farm level analysis also revealed that the gradual shift in the cropping pattern was pronounced in the rural gradient, followed by peri-urban and urban gradients. It is understood that the urban households still had a major share of area under paddy crop, followed by peri urban and rural households. This might be due to the fact that the sample rural farmers are mostly engaged in agriculture and allied activities and depend mainly on agriculture for their livelihood, which forced them to diversify their crop activities to some extent. It was found that the variables, size of land holding, household income and gross irrigated area were highly responsible for the crop diversification in the sample households. On an average, each household maintained about three crops in the rural gradient, about one to two crops in the peri-urban and urban gradients, which reveals the prevalence of crop diversification at the farm level also to some extent. The major constraint faced by the sample respondents were water scarcity and labour scarcity for the land use and crop diversification.

There is a need for strong policy measures to control the cascading effects of development pressures on agricultural lands led by urbanisation process. Hence, the following policy implications are drawn from this study are as follows;

1. The government should avoid taking the agricultural lands for construction of highways and other infrastructure development. Hence, it is suggested that suitable land use policy should be adopted for proper management of land resources to ensure sustainable agricultural growth in the country.
2. Agricultural intensification should also be encouraged, so as to boost agricultural productivity in the rural areas and urban agriculture should be encouraged within urbanised areas for sustainable food supply in the state. Institutional arrangements need to be focussed on the prevention of idling of fertile agricultural lands located close to urban areas for speculative purposes.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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