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## AGRICULTURAL SYSTEM IN PERI-URBAN AREAS OF DELHI: RISKS AND OPPORTUNITIES

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### ABSTRACT:

*In last few decades, India has been witnessing widespread urbanization across the country. Rapid urban expansion beyond the city boundaries leads to conversion of agricultural land to non-agricultural purpose in the surrounding peri-urban areas. From this backdrop, this paper tries to study the changing land use land cover (LULC) pattern and to view the agricultural systems remaining in the peri-urban areas of Delhi metro city. It is found that peri-urbanisation is very much associated with loss of arable lands and land speculation in transitional areas. With loss of agricultural land and incessant population pressure, the agriculture system in these areas is being intensified on the limited lands and diversified crops are being produced to meet*

*the increasing food demands.*

**KEYWORDS:** Agriculture, Peri-urban, Delhi, LULC, Agricultural System.

### 1. INTRODUCTION

In last few decades, India has been witnessing widespread urbanization across the country. As per 2011 Census, as many as 377 million people (i.e. 31.16 percent) are currently living in urban areas. Interestingly the absolute increase of urban population first time outnumbers the rural population in the latest census and this trend is more likely to continue in near future. The large cities are experiencing rapid population growth and as well as spatial expansion resulting “complex interactions with the surrounding rural areas and gradual changes in their land uses and occupations” that transform

them into semi-urban or ‘peri-urban’ areas (Shaw, 2005). Peri-urban areas are those areas which are located outside the city limits and having both the urban and rural land uses (Allen, 2003). They are in transition from rural to urban area following the spatial expansion of cities.

The haphazard and unplanned urban expansion beyond their administrative boundaries poses challenges to the agricultural system in peri-urban areas. These areas are witnessing large scale conversion of agricultural lands to facilitate infrastructure and development activities such as residential complexes, Special Economic Zones (SEZ), airports, information technology hubs, transport corridors, industrial estates (Gowda *et al*, 2012; Ramachandraiah, 2014) as well as for dumping ground for

urban solid waste (Shaw, 2005). The agricultural land in peri-urban areas therefore gets converted to non-agricultural uses and pose a serious threat to the livelihood of the farmers as they do not get job in non-agricultural sectors and become landless casual wage labour or remain unemployed (Mallick and Sen, 2011). On the opposite side, peri-urbanization brings some opportunities to the farmers (Ramachandraiah, 2014). With proximity and accessibility to urban market, quick transport facilities and easily available information, peri-urban agriculture could be more intensified.

The farmers can go for diversified products like 'low volume higher value crops' (flower, capsicum, baby corn, broccoli etc) that facilitate more profits with low labour cost (Midmore and Jansen, 2003; NAAS, 2004; Simon, 2008). Therefore, it can be argued that the processes of peri-urbanization have both unequal risks and opportunities for peri-urban agriculture. The focus of this paper is on the existing agricultural system given the context of loss of arable lands and rapid urban expansion in peri-urban areas of Delhi metropolitan city. In this backdrop, the study tries to study the changes in land use land cover (LULC) pattern in peri-urban Delhi and to view the agricultural aspects such as cropping pattern, cropping intensity, and irrigation facilities of the land in the peri-urban areas.

## 2. DATABASE AND METHODOLOGY

Data related to urbanisation around Delhi metropolis has been collected from Primary Census Abstract, Census of India (2001 and 2011) and agricultural information from Agricultural Census of India (2000-01 and 2010-11) has been used to observe the agricultural aspects such as Land use changes, crops produced, cropping intensity, and irrigation system in the transitional areas. Here, the Peri-urban areas have been represented by the districts around the metropolis Delhi because of data limitation at the lower level (Figure 1). Though the districts are often too large to symbolize as dynamic peri-urban areas, it has the potential to provide an overview of transitional areas for Delhi as a whole. As the data is only available at district level, more detailed study beyond district level is not possible with this secondary data. Some quantitative methods like Cropping Intensity (CI)<sup>1</sup> and Weaver's Crop Combination (CC)<sup>2</sup> method have been used in this study and the results are analyzed by using bivariate mapping, graphs and tables.

## 3. RESULTS AND DISCUSSION

### 3.1 Urbanization and Land Use Land Cover Change

Land use land cover pattern and changes in the peri-urban areas are more complex and dynamic than the usual changes in any other area. As the residential, industrial, commercial and other non-agricultural activities are expanding in this zone, the use of land is changing very rapidly. Conversion of agricultural land to urban uses is a continuous phenomenon mainly along the transport corridors and the lands located adjacent to the city boundary are more prone to conversion.

On the basis of data available from Agricultural Census, fivefold LULC categories have been used to study the land use pattern in peri-urban areas of Delhi. These are forest land, 'land not available for cultivation', 'other uncultivated land excluding fallow land' or simply 'cultivable waste land', 'fallow land', and 'net area sown'. One of the limitations this data has is that the reporting area i.e, the area for which data on land use classification is available varies from 2000-01 to 2010-11 for almost all the districts except Rohtak and Sonipat. To avoid this problem, the percentage coverage under each land use category is used here.

#### 3.1.1 Forest Land

This includes the lands classified as forests by the concerned authority. Out of the total reported area of 1580131 hectares of the peri-urban in 2000-01, only 1.58 percent was under forest cover which further decreased to 0.92 percent in 2010-11 while the national figure is 21.34 percent of the total geographical area (Indian State of Forest Report, 2015 by the Forest Survey of India) (Table 1 & 2). All the districts have very less lands under forest coverage and all facing negative growth over the decade except Gurgaon, Gaziabad and Goutam Buddha Nagar. The worst condition observed in Rotak (0.02) followed by Sonipat (0.12), Faridabad (0.45), Baghpat and Jhajjar. This large scale deforestation in peri-urban areas is a serious threat to the environment.

<sup>1</sup> Cropping intensity (CI) = [Gross Cropped Area / Net Area Sown] \* 100

<sup>2</sup> Weaver's Crop Combination (CC) =  $\frac{\sum (X_1 - X')^2}{N}$ ,

Where,  $X_1$  is the percentage of a crop to total cropped area,  $X'$  is the theoretical percentage and N is number of crops selected

**Table 1: LULC Classes in Peri-urban Areas of Delhi Metropolis, 2000-01**

Districts	Forests		Not Available for Cultivation		Other Uncultivated Land Excluding Fallow Land		Fallow Land		Net Area Sown		Reporting Area for Land Use
Faridabad	2705	<b>1.30</b>	42684	<b>20.52</b>	1686	<b>0.81</b>	984	<b>0.47</b>	159975	<b>76.90</b>	208034
Gurgaon	2939	<b>1.09</b>	52806	<b>19.56</b>	1615	<b>0.60</b>	24178	<b>8.96</b>	188447	<b>69.80</b>	269985
Jhajjar	3826	<b>2.00</b>	21705	<b>11.35</b>	13571	<b>7.10</b>	5690	<b>2.98</b>	146363	<b>76.57</b>	191155
Rohtak	4025	<b>2.41</b>	11916	<b>7.14</b>	4840	<b>2.90</b>	4955	<b>2.97</b>	141111	<b>84.58</b>	166847
Sonipat	7073	<b>3.32</b>	21161	<b>9.93</b>	7572	<b>3.55</b>	2098	<b>0.98</b>	175177	<b>82.21</b>	213081
Baghpat	1525	<b>1.13</b>	16866	<b>12.54</b>	2079	<b>1.55</b>	3657	<b>2.72</b>	110404	<b>82.07</b>	134531
Gautam Buddha Nagar	400	<b>0.20</b>	32557	<b>16.65</b>	7680	<b>3.93</b>	15759	<b>8.06</b>	139097	<b>71.15</b>	195493
Ghaziabad	2470	<b>1.23</b>	38175	<b>18.99</b>	4019	<b>2.00</b>	14228	<b>7.08</b>	142113	<b>70.70</b>	201005
Peri-Urban Delhi	24963	<b>1.58</b>	237870	<b>15.05</b>	43062	<b>2.73</b>	71549	<b>4.53</b>	1202687	<b>76.11</b>	1580131

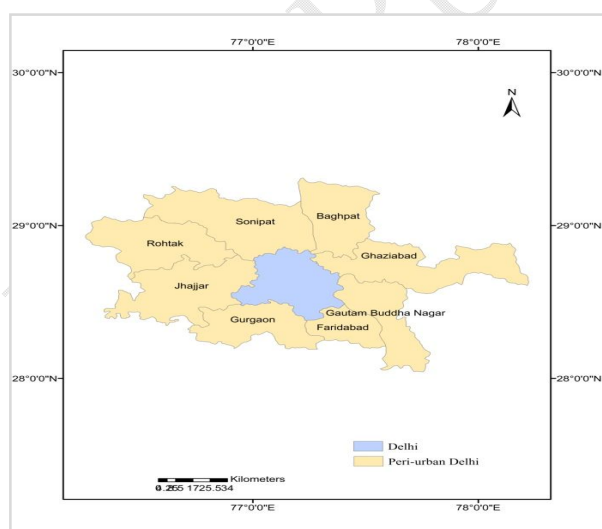
Source: *Computed from Agricultural Census of India, 2000-01*

Note- Absolute values are in hectares and the **bold italic** figures denote percentage of each class to total reported area.

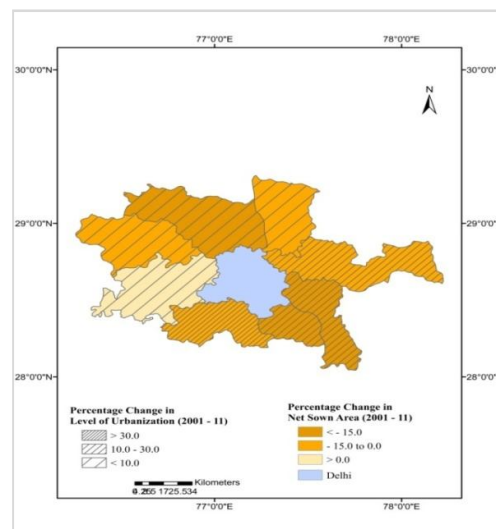
### 3.1.2 Net Sown Area

As observed in Table 1 & 2, 76.11 percent of peri-urban area is reported under cultivation in 2000-01 which is decreased to 71.74 percent in 2010-11 due to rapid urbanization and urban expansion. This agricultural land has been converted to non-agricultural land to facilitate new residential estate, industries, transport systems and other urban aspects. Nangia (1978) in a study of Delhi metropolitan region reveals that spatial expansion of the metropolis has not kept pace with its population and economic growth. So, the spillover effects are being spread over the settlements around the city which persist to function for the city and bear some of its population as well as economic loads.

It is observed that there is a negative relation between urbanization and agricultural lands, as an increase in level of urbanization causes to decrease in cultivated lands. All the districts in peri-urban areas are testimony to this relationship, though the magnitude varies. For instance, Faridabad and Gautam Buddha are the two districts that show highest increase in urbanization and subsequently maximum loss of agricultural land (- 28.48 and -19.20 percent respectively) (See Figure 2).



**Figure 1: Delhi and Surrounding Peri-urban Areas**



**Figure 2: Urbanization and Loss of Agricultural Land in Peri-urban Delhi, 2001-2011**

**Table 2: LULC Classes in Peri-urban Areas of Delhi Metropolis, 2010-11**

Districts	Forests		Not Available for Cultivation		Other Uncultivated Land Excluding Fallow Land		Fallow Land		Net Area Sown		Reporting Area for Land Use
Faridabad	323	<b>0.45</b>	35808	<b>49.68</b>	271	<b>0.38</b>	772	<b>1.07</b>	34897	<b>48.42</b>	72071
Gurgaon	3560	<b>2.96</b>	33184	<b>27.62</b>	1296	<b>1.08</b>	286	<b>0.24</b>	81823	<b>68.10</b>	120149
Jhajjar	-	-	14924	<b>7.81</b>	7103	<b>3.72</b>	1607	<b>0.84</b>	167501	<b>87.63</b>	191135
Rohtak	40	<b>0.02</b>	8052	<b>4.83</b>	14401	<b>8.63</b>	4557	<b>2.73</b>	139797	<b>83.79</b>	166847
Sonipat	265	<b>0.12</b>	61284	<b>28.76</b>	7115	<b>3.34</b>	-	-	144417	<b>67.78</b>	213081
Baghpat	1525	<b>1.13</b>	18818	<b>13.94</b>	1775	<b>1.31</b>	3729	<b>2.76</b>	109136	<b>80.85</b>	134983
Gautam Buddha Nagar	2003	<b>1.60</b>	30110	<b>24.01</b>	2970	<b>2.37</b>	25175	<b>20.07</b>	65164	<b>51.96</b>	125422
Ghaziabad	3641	<b>1.76</b>	44000	<b>21.26</b>	3437	<b>1.66</b>	15730	<b>7.60</b>	140126	<b>67.72</b>	206934
Peri-urban Delhi	11357	<b>0.92</b>	246180	<b>20.00</b>	38368	<b>3.12</b>	51856	<b>4.21</b>	882861	<b>71.74</b>	1230622

Source: Computed from Agricultural Census of India, 2010-11

Note- Absolute values are in hectares and the **bold italic** figures denote percentage of each class to total reported area.

### 3.1.3 Land Not Available For Cultivation

This includes all the lands occupied by non-agricultural uses and barren lands e.g., buildings, roads, railway, water bodies etc which cannot be used for agricultural purpose. The statistics show that 15.05 percent of the reported area was under this category in 2000-01 and continues to grow to 20 percent in 2010-11. By this increasing trend, one can understand the effect of urbanization on land use changes in peri-urban areas of Delhi metropolitan region.

District wise analysis shows that there is a variation of the land under this category and this variation becomes more visible in 2010-11 (49.68 to 4.83). Faridabad is the district having highest coverage of land under not available for cultivation (49.68 percent) in 2010-11 which is two times higher than the figure of 2000-01 (20.52). Followed by, Sonipat, Gurgaon, Gautam Buddha Nagar also report rapid conversion of lands to non-agricultural purpose. On the other hand, Rohtak and Jhajjar are the only two districts where lands in this category have been decreased in 2010-11. This can be attributed to their low level of urbanization of these districts.

### 3.1.4 Other Uncultivated Land Excluding Fallow Land

This is the land which includes the permanent pasture and grazing land, land under miscellaneous trees and cultivable wasteland. In peri-urban Delhi, 2.73 percent of the total reported land is cultivable wasteland in 2000-01 and increases to 3.12 percent in 2010-11. District wise analysis shows that Rohtak is the only place where cultivated wasteland has been increased significantly from 2.9 in 2000-01 to 8.63 percent in 2010-11.

### 3.1.5 Fallow Land

Fallow land is the land which was taken up for cultivation but is temporarily out of cultivation for some period but not more than five years. The peri-urban area is observed to have 4.21 percent of reported land under fellow land in 2010-11. Ghaziabad, Faridabad and Gautam Buddha Nagar which are the highly urbanized districts in peri-urban Delhi, report an increasing trend of fallow land. This is because of the land speculation as the peri-urban areas are most dynamic region and the land broker holds the land out of agriculture hoping high land value in near future.

### 3.2 Changing Face of Agriculture

The most important resource in agriculture is the land. As discussed from the land use change, the cultivated land has been decreasing with the expansion of urbanization in the peripheral areas. In addition, the peri-urbanization also stimulate changes in the behaviour of farmers towards agriculture. With tempt of increasing land value and emerging urban opportunities in peri-urban areas, farmers tend to move towards non-agricultural activities instead of sticking to primary sector. In this given circumstance, an attempt is made to study the changing face of agriculture in peri-urban areas of Delhi.

#### 3.2.1 Cropping Intensity

The cropping intensity in peri-urban areas varies with the changing environment. It is well known that the north-western part of India is highly developed in agriculture since green revolution. The peri-urban Delhi experiences high level of cropping intensity and it has been increasing over the decades from 154.66 percent to 165.68 percent (Table 3). The improved infrastructural facilities – fertilizers, new varieties seeds and irrigation facilities smooth the progress of intensity of crops in this area. There is an alarming food demand in peri-urban areas due to rapid population explosion and a decline in net sown area, increasing cropping intensity is the only way to fulfill this demand. It is observed that almost all the districts have high cropping intensity and experienced increase in last decades which show a positive sign. Sonipat is the district securing the highest level of cropping intensity, 213.85 percent in 2011 that means the net sown area is cultivated more than twice. Besides, Faridabad, Ghaziabad, Rhotak and Gautam Buddha Nagar also experience higher cropping intensity.

**Table 3: Cropping Intensity in Peri-urban Delhi**

Districts	2000-01	2010-11
Faridabad	165.50	190.74
Gurgaon	159.25	138.80
Jhajjar	157.16	143.56
Rohtak	152.29	164.41
Sonipat	161.87	213.85
Baghpat	157.99	160.04
Gautam Buddha Nagar	119.19	153.55
Ghaziabad	159.38	163.21
Peri-Urban Delhi	154.66	165.68

*Source: Computed from Agricultural Census, 2001 & 11*

#### 3.2.2 Cropping Pattern

Cropping pattern in an agricultural region is mainly dependent on natural factors like rainfall and soil condition as well as other factors like irrigation facilities, new varieties of seeds and use of fertilizer. The peri-urban areas throughout the country experience continuous decline in net sown area due to urban spread which is also an important playing factor to determine the cropping pattern.

To better understand the cropping pattern in the peri-urban area, Weaver's Crop Combination method has been applied here. It is observed that peri-urban area of Delhi has a crop combination of 11 crops with wheat dominating 44.52 percent of the total cropped area in 2000-01. As this region is under north-western part of India which is wheat bucket reveals their control over wheat production. Besides, other crops are fodder crops, rice, sugarcane, bajra, jowar, oilseed, pulses, vegetables, barley and maize. Fodder crops are also important covering 12.56 percent of the cropped area more than that of rice. This is because of the fact that small cultivators who are engaged in other activities as main occupation and cultivating land as part-time farmers, cannot afford to grow such crops which need regular care and hence prefer fodder crop required for animals (Tarsem, 2001). The crop combination is reduced to 10 crops in 2010-11 with wheat as dominating one (42.52 percent of cropped area) but slightly less than last decade. Rice has emerged as new dominant crop covering 16.66 percent of total cropped area from

10.82 percent in 2000-01. Barley and maize have been excluded from the combination pattern in 2010 and what is noteworthy that green manure becomes the new entrant. The cultivators are becoming more interested to organic farmers and started to grow the green manure crops to increase the fertility of the soil. As urbanization prevailing, with proximity and accessibility to urban market and easily available information, the farmers are now going for more non-durable and perishable crops like vegetables and fruits rather than with the traditional staple crops (Midmore and Jansen, 2003; Ramachandraiah, 2014). Therefore, an emerging diversification observed in crop production in peri-urban areas by getting the advantages of urbanization.

### 3.2.3 Irrigation

Irrigation facility is one of the important factors indispensable for agricultural development in a region. The north-western part of India particularly Punjab, Haryana and Eastern Uttar Pradesh has the benefit of irrigation facility. This is the region which has been growing prosperously after the green revolution only due to the assured irrigation system. Therefore, it is observed that the peri-urban areas have a good irrigation system, as 94.80 percent of total gross cropped area is covered by irrigation facility (Table 4). The irrigation facilities are almost similar across the districts under study.

**Table 4: Percentage of Irrigated land to Total Gross Cropped Area**

Districts	2000-01	2010-11
Faridabad	93.84	91.04
Gurgaon	71.73	99.88
Jhajjar	89.63	98.90
Rohtak	96.72	99.44
Sonipat	98.52	85.16
Baghpat	99.89	99.59
Gautam Buddha Nagar	99.99	100.00
Ghaziabad	99.94	100.00
Peri-Urban Delhi	93.12	94.80

*Source: Computed from Agricultural Census, 2001 & 11*

## 4. CONCLUSION

It is observed that Delhi metro city has been experiencing rapid growth and as well as spatial expansion. Therefore the peri-urban transitional areas, where the urban and rural activities mix up and make a haphazard landscape, are going under drastic changes in land use land cover pattern. There has been a continuous decline in net sown area in peri-urban areas of this metro city and a consistent rise in fallow land and lands not available for cultivation. This is because of increasing non-agricultural activities and land speculation in transitional areas. Significant changes have also been observed in the cropping pattern from 2000-01 to 2010-11. As far as crop combination is concerned, wheat is the single most dominant crop covering more than 42 percent out of total cropped area. Over the last decade, barley and maize have been excluded when rice emerged as second dominant crop with its significant 16.66 percent areal coverage. In additions, the cultivators are observed to be more interested in organic farming and started to growing the green manure crops to increase the fertility of the soil. The cropping intensity in peri-urban areas is observed to be very high and increasing over the years to meet the ever increasing food demand given huge population pressure and declining net sown area triggered by urban expansion. The peri-urbanization on the other hand facilitates the peri-urban cultivators to go for diversified crops – from traditional stable crops to high value non-durable and perishable ones like vegetables and fruits providing accessibility to urban market, transport facilities and information.

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