

Valuation of Cropland Ecosystem Services



Chapter 5

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“Agriculture is our wisest pursuit, because it will in the end, contribute most to real wealth and happiness”

Thomas Jefferson

Introduction

Agriculture and allied sectors are pivotal to the sustainable growth and development of any country, but is significantly marked in the Indian context. Not only does it meet the food and nutritional requirements of 1.3 billion Indians, agriculture is the primary source of livelihood for about 58 per cent of India's rural households or 40 percent of the total households. As per the NSS Situation Assessment Survey³⁴ conducted during 2012-13, agricultural activity was reported to be the principal source of income for majority of the households in all the major States, except Kerala. Uttar Pradesh, with an estimate of 18.05 million agricultural households, accounted for about 20 percent of all agricultural households in the country, while Rajasthan had highest percentage of agricultural households (78.4 percent) among its rural households. Even the lowest percentage share of agricultural households in rural households was a significant 27.3 percent in Kerala. The sustainability of these farmers is crucial for livelihoods in rural areas and for the entire country.

2. It is well-documented that the forward and backward linkage effects of agriculture growth increase the incomes in the non-agriculture sector. The growth of some commercial crops has significant potential for promoting exports of agricultural commodities and bringing about faster development of agro-based industries. Thus agriculture not only contributes to overall growth of the economy but also reduces poverty by providing employment and food security to the majority of the population in the country and thus it is the most inclusive growth sectors of the Indian economy.

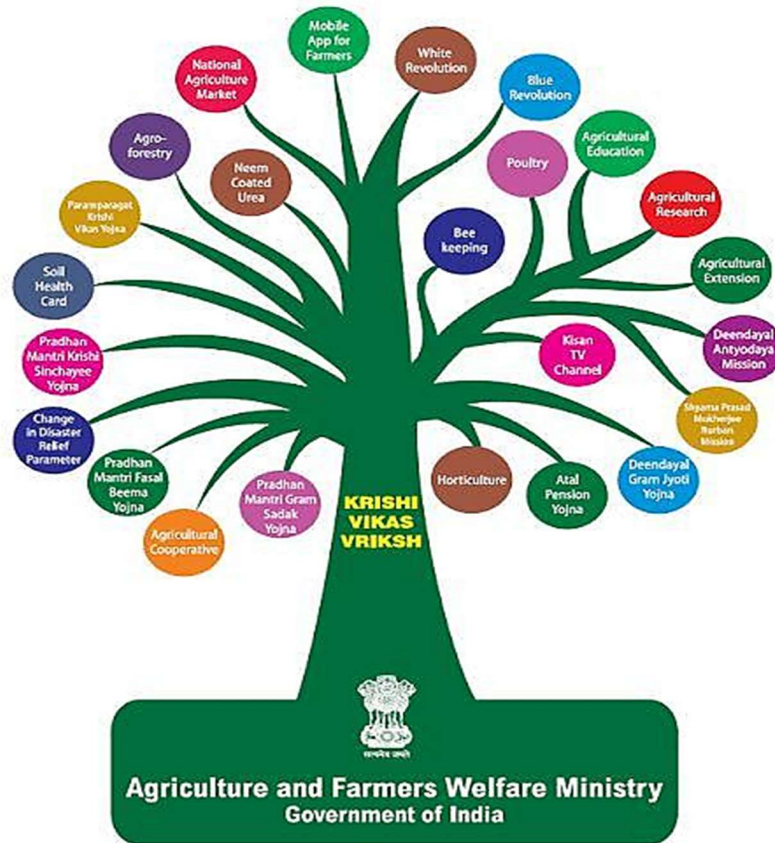
3. The sector is, however, plagued with several issues. The above-cited NSS Survey estimates the average gross cropped area per agricultural household during 2012-13 was

³⁴ Key Indicators of Situation of Agricultural Households in India(NSS 70th Round),MOSPI
http://mospi.nic.in/sites/default/files/publication_reports/KI_70_33_19dec14.pdf

0.937 hectare. Land fragmentation is said to harm productivity in a number of ways. First, fragmented land holdings can increase transport costs. If the plots are located far from the home, and far from each other, there is a waste of time for the workers spent on travelling in between the plots and the home. Management, supervision and securing of scattered plots can also be more difficult, time consuming, and costly. Small and scattered plots and waste land area require more land for fencing, border constructions, and paths and roads. Small fragmented land holdings might also cause difficulties to grow certain crops, and prevent farmers from changing to high profit crops. More profitable crops, like for example fruit crops, require larger plot areas, so if the farmers only possess small and fragmented plots they may be forced to grow only less profitable crops. Another aspect is that of the irrigation infrastructure. Since independence, there has been a rapid expansion of irrigation infrastructure in India. However, despite the large scale expansion, only about one third of total cropped area is irrigated today and two third of cropped areas is still dependent upon monsoon. So, with the options for utilising newly emerging technologies and mechanisation being limited in the case of small-holdings, which generally are also monsoon dependent, the cost of cultivation per hectare is generally high in small and marginal farms than medium and large farms and consequently, net farm income per hectare is in large holdings higher than that in small holdings.

4. To counter these issues, a number of initiatives have been taken up by the Government in the interest of farmers like distribution of Soil Health Cards, nutrient-based subsidy(NBS) policy for P and K fertilizers, organic farming, Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Paramparagat Krishi Vikas Yojna (PKVY), National Mission on Sustainable Agriculture (NMSA), National Agriculture Market scheme (e-NAM), National Water Mission, National Mission for a Green India and Mission for Integrated Development of Horticulture. A 24-hour television channel named DD Kisan and a toll-free Kisan Call Centre have also been launched for Indian farmers to help in sorting out any kind of agricultural problems. The Krishi Vikas Vriksh shown in **Figure 5.1** given below depicts several initiatives /schemes launched by Government of India.

Figure 5.1. Krishi Vikas Vriksh

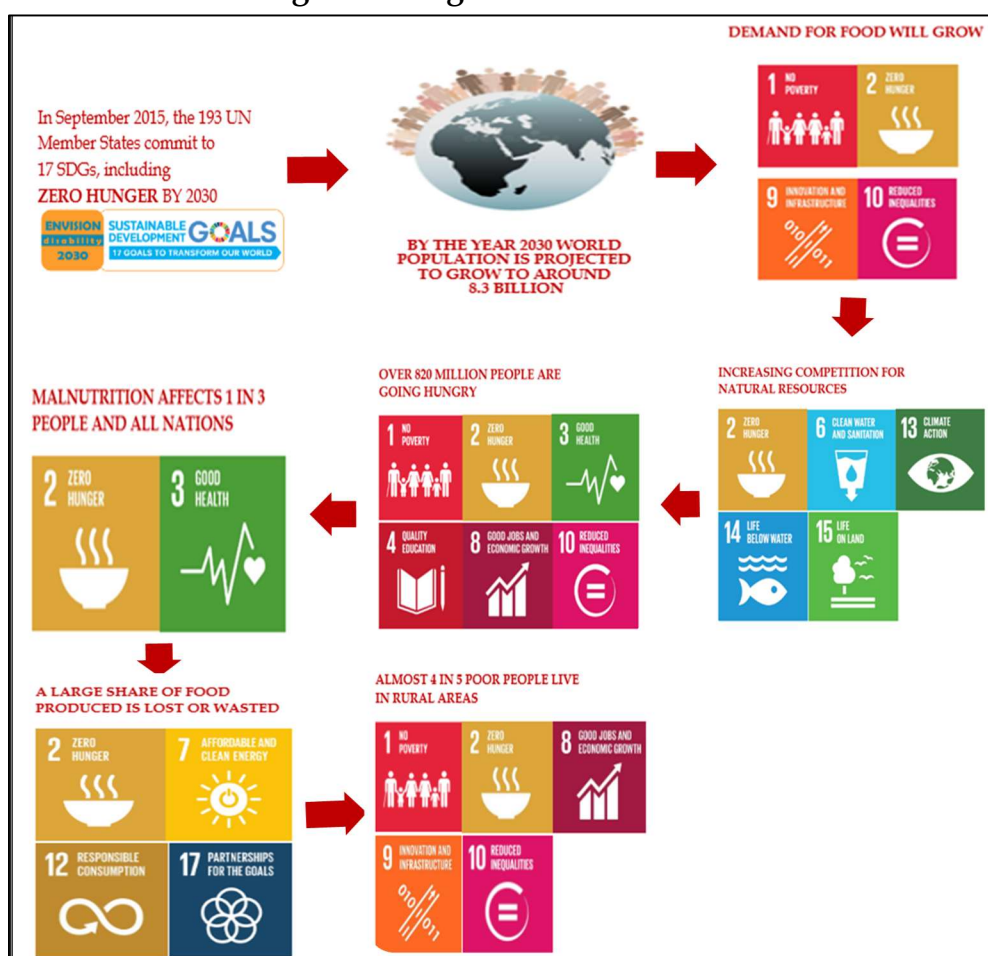


5. In respect of farmers with small holdings³⁵, apart from the above-mentioned initiatives, under the Pradhan Mantri Kisan Samman Nidhi Yojana (PM-Kisan), Rs. 2,021 crore was transferred to the bank accounts of more than 10 million small and marginal farmers as minimum income support on February 2019. Earlier in September 2018, the Government of India announced Rs 15,053 crore procurement policy named 'Pradhan Mantri Annadata Aay Sanrakshan Abhiyan' (PM-AASHA), under which states can decide the compensation scheme and can also partner with private agencies to ensure fair prices for farmers in the country. To enable the farmers' cooperatives in getting maximum benefits of digital technology, the government has provided Rs. 2,000 crore for computerisation of Primary Agricultural Credit Society (PACS). A new AGRI-UDAAN programme has been introduced to mentor start-ups and to enable them to connect with potential investors with an aim to boost innovation and entrepreneurship in agriculture.

6. Even though the share of the farm sector is reducing in the economy, with the progress in agriculture directly linked to the achievement of several Sustainable Development Goals (see **Figure 5.2**), the sector needs more emphasis than ever before.

³⁵ Various press releases of the Ministry of Agriculture and Farmers Welfare;
<https://pib.gov.in/PressReleaseFramePage.aspx?PRID=1568060>

Figure 5.2: Agriculture and SDGs



Agricultural ecosystems

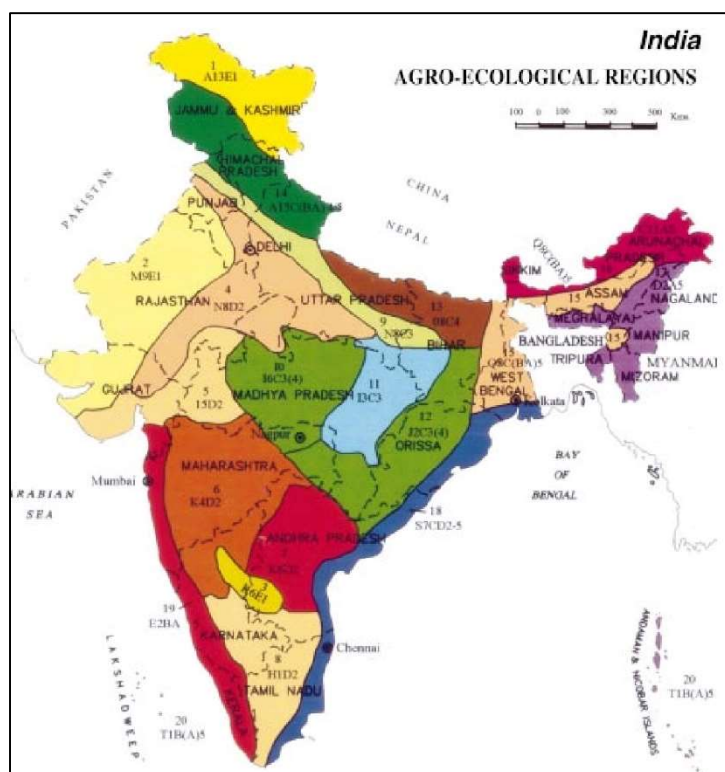
7. Agroecosystems are both providers and consumers of ecosystem services. Humans value these systems chiefly for their provisioning services, and these highly managed ecosystems are designed to provide food, forage, fibre, bioenergy and pharmaceuticals. The contribution of the ecosystem to crop production, i.e. the total and combined result of processes taking place in cropland that support crop production such as infiltration of water, the absorption of plant nutrients by soil particles and the resupply of these particles to plants (nutrient cycling), soil retention and regulation of soil fertility. Whether any particular agricultural system provides such services in support of provisioning depends on management, and management is influenced by the balance between short-term and long-term benefits.

8. Management practices also influence the potential for 'disservices' from agriculture, including loss of habitat for conserving biodiversity, nutrient runoff,

sedimentation of waterways, and pesticide poisoning of humans. However, appropriate management can ameliorate many of the negative impacts of agriculture, while largely maintaining provisioning services.

9. The diversity of India is unique and presents endless varieties of physical features and cultural patterns. With a cropland spanning an area of about 156 million hectares³⁶, India is a vast country with great diversity of physical features like dry deserts, evergreen forests, snowy Himalayas, a long coast and fertile plains. Certain parts in India are so fertile that they are counted amongst the most fertile regions of the world, while other are so unproductive and barren that hardly anything can be grown there.

From the point of climate too, there is a sharp contrast; India has every variety of climates from the blazing heat of the plains, as hot in places as hottest Africa to freezing points of the Himalayas as in the Arctic. Consequently, the agricultural ecosystems in India show tremendous variation, as they are driven by diverse cultures under diverse socioeconomic conditions in diverse climatic regions. India has 20 different agro-ecological regions and 60 agro-ecological sub-regions.



10. The agricultural practices in India include, among others, subsistence farming, plantations, rotation farming, annual crop monocultures, temperate perennial orchards, shifting cultivation systems, smallholder mixed cropping systems, paddy rice systems and terrace cultivation. Also, India has three distinct agricultural/cropping seasons viz. kharif, rabi and zaid. In India there are specific crops grown in these three seasons. For example, rice is a kharif crop whereas wheat is a rabi crop. This variety of agricultural systems results in a highly variable assortment and quantity of ecosystem services.

³⁶ National Remote Sensing Centre, LULC, 2011-12; as retrieved from http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/EnviStats/3_Chapter%201-%20Land.pdf

11. In maximizing the value of provisioning services, agricultural activities are likely to modify or diminish the ecological services provided by unmanaged terrestrial ecosystems, but appropriate management of key processes may improve the ability of agroecosystems to provide a broad range of ecosystem services.

Approaches for Analysing Ecosystem Services

12. The overarching goal of measuring and valuing ecosystem services is to use that information to shape policies and incentives for better management of ecosystems and natural resources. SEEA prescribes the use of 'resource rent method' for estimating the value of this ecosystem service provided by croplands. The measurement of Resource Rent provides a gross measure of the return to crop production. Since households have a high level of ownership or influence over farming on Agricultural Land, valuation of Resource Rent in monetary terms may also provide useful information for assessing future streams of income from Agricultural Land for households.

13. Valuation of Resource Rent helps to compare Agricultural Land with different environmental assets using a common numeraire. Agricultural Land can be compared against other assets in order to assess relative returns, national wealth and similar types of analysis. One of the methods prescribed in SEEA for estimating the resource rent is the appropriation method. The **appropriation method** estimates the resource rent using the actual payments made to owners of environmental assets. Legal owners collect the entire resource rent (in terms of rental value of owned land or rent paid for leased-in land) derived from extraction of the resources that they own.

Sources of statistics on different aspects of agriculture in India³⁷

14. Ministry of Agriculture and Farmers Welfare, Government of India, collects and collates various types of data on different facets of agriculture. Price policy for agricultural commodities constitutes an important element of overall agricultural economic policy in India. Minimum Support Prices (MSPs) for important cereals, pulses, oilseeds, and other commercial crops, namely, cotton, jute and sugarcane, are fixed by the Government every year on the basis of the recommendations made by the Commission for Agricultural Costs and Prices (CACP). The most important factor considered by the CACP in making its recommendations on MSPs for different crops is the cost of cultivation/production for which the database is provided by the Directorate of Economics and Statistics (DES) of the Ministry of Agriculture & Farmers Welfare through a study on cost of cultivation. CACP also take into account the advance information on the production of different crops, supply-demand scenario, as well as price movements in both the domestic and international markets, while making these recommendations.

³⁷ <http://eands.dacnet.nic.in/rti/Annex%20I.htm>

15. The effectiveness of price policy in boosting production and productivity of agriculture in tune with domestic as well as external demand cannot be assessed in the absence of regular data on area, production and yield of different crops. Similarly, data on domestic and international prices for various agricultural commodities, trends in procurement, offtake and stocks of foodgrains, consumption of different agricultural commodities, their exports and imports, etc. assume immense significance in the emerging external economic environment, which is increasingly influenced by the World Trade Organisation. The importance of a sound data/ information base on different facets of agriculture cannot therefore be overemphasized. The DES has several schemes to cater to these needs of datasets on the agriculture in India. The key points of these schemes are given in the following paragraphs.

I. Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in India

16. The Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in India is being implemented since 1970-71, with the following objectives:

- (i) collection and compilation of field data on cost of cultivation and cost of production in respect of 28 crops; and
- (ii) generation of estimates of cost of cultivation and cost of production of various crops in different States covered under the scheme.

17. DES gets this study conducted in 19 States through Agricultural and other Universities covering 28 crops. Under the scheme, the field data pertaining to the cost of cultivation/ cost of production are collected, compiled and analysed. The study covers both the cash and non-cash costs. The cash costs include the costs for which farmer spends money for acquisition of material inputs like seeds, fertilizer, chemicals or labour inputs like hired labour etc. On the other hand, non-cash costs are attributable to items of cost, which do not require spending money. These may be items of cost like family labour, payments made in kind, home grown seeds, manure etc., exchange labour, depreciation, interest on operating capital etc. The field data under the scheme are collected on the Cost Accounting Method under which daily entries of debit/credit for the expenditure/income are made in order to assess the total cost incurred/benefit accrued by/ to each farmer covered under the scheme. The detailed questionnaire is filled up/updated on monthly/annual basis after making enquiries on daily basis from farm holdings distributed equally across different size classes.

II. *Improvement of Agricultural Statistics*

18. The basic objective of this Scheme is to collect and improve agricultural statistics of Principal Agricultural Crops and selected Horticultural Crops. The Scheme has four components namely (i) Timely Reporting Scheme, (ii) Improvement of Crop Statistics, (iii) Establishment of an Agency for Reporting of Agricultural Statistics (EARAS) and (iv) Crop Estimation Survey on Fruits & Vegetables.

19. The scheme has different components, but primarily, the objective is to obtain estimates of area and production of the identified principal crops, in each season, with break-up of area under irrigated/unirrigated and traditional /high yielding varieties of crops on the basis of priority enumeration conducted on the basis of random sample of 20% of villages by a specific date. The scheme also has provision for supervision and monitoring to improve the quality of statistics through a sample check of area enumeration and crop-cutting experiments.

III. *Land Use Statistics*

20. Land Use Statistics is a comprehensive and systematic account of natural endowment of land spanning over 328 million hectares of geographic space of the country, adopting the uniform concept of nine-fold land use classification. Crop area statistics is the major segment of LUS. Crop statistics assimilates the diverse agro climatically influenced crop acreage and production details of numerous crops, grown over 140 million hectares of net sown area with about 141 percent cropping intensity. The area statistics broadly covers the utilisation pattern of land with detailed statistics relating to land put to agricultural uses. This includes the area sown under different crops in different seasons.

Methodology Used for Estimating Resource Rent

21. Three main sources of information that have been used for this compilation are:

- i. Cost of Cultivation Studies
- ii. Information on Area, Production and Yield (APY) of major crops
- iii. Land Use Statistics

22. The steps followed for the compilation are as under:

- i. Rent for CCS States and CCS Crops
 - Total rent per hectare, as the sum of rent paid for leased in land or rental value of own land, is taken as it is for the state x crop combination that is available in CCS. In the analysed dataset, there were 19 CCS States and 24 CCS Crops.

- Rent per hectare is then imputed for all states & all crops that are available in CCS. For states where CCS is not available for some crops, missing rent is imputed crop-wise using rent from the neighbouring state.
- For states where CCS is not available for some crops and CCS of those crops is also not available in neighbouring states, rent is imputed with minimum rent of that state itself.
- ii. Imputation for Non-CCS States & CCS Crops
 - For Non-CCS States, rent for the CCS crops has been imputed from the nearest CCS neighbour.
- iii. Imputation for Non-CCS Crops
 - For crops where CCS is not available for any state, rent has been imputed with positive minimum rent of that state itself.
- iv. Since crop-wise information is available for Gross Area Sown and not Net Area Sown, an adjustment factor has been derived from Land Use Statistics.
 - Adjustment factor for Net Area Sown = Net Area Sown/Gross Area Sown

Resource Rent for State for a Crop for a Year

- v. $RR(S)_{crop} = [\{ \text{Rent per hectare (State)} \times \text{Area under crop (State)} \times \text{Adjustment for Net Area Sown}]$

Resource Rent for State per unit quantity³⁸ of Crop for a Year

- vi. $RR(S)_{crop} \text{ per tonne} = RR(S)_{crop} / [\text{Production (State)}]$

Resource Rent for District for a Crop for a Year

- vii. $RR(D)_{crop} = RR(S)_{crop} \text{ per tonne} \times \text{Production (district)}$

Total Resource Rent for a district for a Year

- viii. $RR(D) = \text{total of all crops as given in APY}$

23. Valuation of cropland ecosystem service has been done using a three-year average of Resource Rent (per tonne) to remove volatility in Resource Rents over time/years; for instance, average of 2004-05, 2005-06 & 2006-07 has been taken for the year 2005-06. Considering multiple years is expected to negate excessive fluctuations due to contingent events that happened in specific years. Resource rent in the publication has been shown for the years 2005-06, 2011-12 and 2014-15 in terms of Resource rent per unit of geographic area of the district. This shows the combined contribution of land resources in agriculture, as well as the share of crop land in the district.

24. The quintile distribution of the districts for these estimates for the years 2005-06, 2011-12 and 2014-15 are given in **Tables 5.1 to 5.3**, while the corresponding maps are given in **Figure 5.3**. The district-wise detailed estimates for the three years are given in **Statement 5.1**.

³⁸ Tonnes for all crops, except coconut, where the production is given in 'nuts'.

Table 5.1: Quintile Distribution of Districts in respect of Resource Rent, 2005-06

State	2005-06						2005-06 Total
	Very Low	Low	Medium	High	Very High	No Data	
Andaman and Nicobar Islands	1						1
Andhra Pradesh		3	7	8	4	1	23
Arunachal Pradesh	16						16
Assam	6	15	6				27
Bihar	2	4	13	16	3		38
Chandigarh		1					1
Chhattisgarh	4	6	5	2			17
Dadra and Nagar Haveli			1				1
Daman and Diu	1	1					2
Delhi		1					1
Goa		1					1
Gujarat	1	6	11	5	2		25
Haryana			1	2	17		20
Himachal Pradesh	7	5					12
Jammu and Kashmir	7	5	1				13
Jharkhand	19	3					22
Karnataka	1	7	10	9			27
Kerala			2	3	9		14
Madhya Pradesh	3	14	15	15	1		48
Maharashtra	2	15	13	3		2	35
Manipur	5		4				9
Meghalaya	7						7
Mizoram	8						8
Nagaland	6	1		1			8
Odisha	3	14	6	7			30
Puducherry			1	1	2		4
Punjab					17		17
Rajasthan	9	5	6	11	1		32
Sikkim	1	3					4
Tamil Nadu		4	10	12	3	1	30
Telangana							
Tripura		1					1
Uttar Pradesh	1	1	3	20	45		70
Uttarakhand	9	2			2		13
West Bengal			3	3	12	1	19

Demarcation of Classes:

Very Low- < Rs. 586	Low - Rs. 586 to Rs.1339	Medium - Rs. 1339 to Rs. 2119
High - Rs. 2119 to 3643		Very High - Rs. 3643 to Rs. 12222

Table 5.2: Quintile Distribution of Districts in respect of Resource Rent, 2011-12

State	2011-12						2011-12 Total
	Very Low	Low	Medium	High	Very High	No Data	
Andaman and Nicobar Islands	1						1
Andhra Pradesh		5	4	8	5	1	23
Arunachal Pradesh	16						16
Assam	3	17	7				27
Bihar	1	3	21	12	1		38
Chandigarh		1					1
Chhattisgarh	7	8	8	3	1		27
Dadra and Nagar Haveli		1					1
Daman and Diu	1	1					2
Delhi							
Goa		1					1
Gujarat	1	8	10	6	1		26
Haryana			1	2	18		21
Himachal Pradesh	9	3					12
Jammu and Kashmir	14	7	1				22
Jharkhand	20	4					24
Karnataka	1	9	10	8	2		30
Kerala				6	8		14
Madhya Pradesh	1	14	11	19	5		50
Maharashtra	2	6	14	10	1	2	35
Manipur	5		1	3			9
Meghalaya	6	1					7
Mizoram	8						8
Nagaland	10		1				11
Odisha	5	13	4	3	5		30
Puducherry			2	2			4
Punjab	1				21		22
Rajasthan	3	13	8	9			33
Sikkim	4						4
Tamil Nadu		5	17	6	3	1	32
Telangana							
Tripura		1					1
Uttar Pradesh		1	4	21	46		72
Uttarakhand	8	3		1	1		13
West Bengal		1	2	7	8	1	19

Demarcation of Classes:

Very Low- < Rs. 1033 Low - Rs. 1033 to Rs.2724 Medium - Rs. 2724 to Rs. 4069
 High - Rs. 4069 to 7303 Very High - Rs. 7303 to Rs. 34816

Table 5.3: Quintile Distribution of Districts in respect of Resource Rent, 2014-15

State	2014-15						2014-15 Total
	Very Low	Low	Medium	High	Very High	No Data	
Andaman and Nicobar Islands	1						1
Andhra Pradesh		4	1	3	5		13
Arunachal Pradesh	18						18
Assam	2	10	10	5			27
Bihar	1	1	16	18	2		38
Chandigarh		1					1
Chhattisgarh	5	7	7	6	2		27
Dadra and Nagar Haveli		1					1
Daman and Diu	1	1					2
Delhi							
Goa		1					1
Gujarat	5	9	13	5	1		33
Haryana			1	3	17		21
Himachal Pradesh	7	5					12
Jammu and Kashmir	17	4	1				22
Jharkhand	12	12					24
Karnataka	1	5	8	14	2		30
Kerala				4	10		14
Madhya Pradesh	1	15	12	19	4		51
Maharashtra	5	13	10	5	1	2	36
Manipur	5		1	3			9
Meghalaya	9	2					11
Mizoram	8						8
Nagaland	8	2		1			11
Odisha	2	12	11	4	1		30
Puducherry		1	1	1			3
Punjab					22		22
Rajasthan	7	8	15	3			33
Sikkim	3	1					4
Tamil Nadu		5	14	7	5	1	32
Telangana		3	1	5		1	10
Tripura		1					1
Uttar Pradesh		6	5	23	41		75
Uttarakhand	11				2		13
West Bengal	1		3	1	14	1	20

Demarcation of Classes:

Very Low- < Rs. 1616 Low - Rs. 1616 to Rs.3303 Medium - Rs. 3303 to Rs. 5192
 High - Rs. 5192 to 8701 Very High - Rs. 8701 to Rs. 29260

Figure 5.3: India's LULC Map and quintile distribution of Cropland Ecosystem Services

