EnviStats India
Explainer Series

THEME: CROPLANDS

Measuring Cropland Fragmentation through Gini Index of Land Concentration

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Access

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Revision Summary of this Document

Version Number	Date of Issue	Brief Description of Change
Ver1.0	April 8, 2021	First Version

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Introduction to SEEA Ecosystem Condition Accounts

1. The System of Environmental Economic Accounting (SEEA) Framework is a multipurpose conceptual framework for understanding the interactions between the economy and the environment, and for describing stocks and changes in stocks of environmental assets. It is a statistical framework consisting of a comprehensive, coherent set of tables and accounts, which guides the compilation of the consistent and comparable statistics and indicators very relevant for policy making, analysis and research. In the context of ecosystems, SEEA helps to form linkages between the ecosystems and the economy through a number of accounts - the extent accounts, the condition accounts and the ecosystem services accounts.

2. In ecology, the description of ecosystem condition is strongly rooted in the concept of ecosystem integrity, which implies an unimpaired condition of being complete or undivided. Ecosystem integrity is defined as the ecosystem's capacity to maintain it characteristic composition, structure, functioning and self-organisation over time within a natural range of variability. Ecosystems with high integrity or condition are typically more resilient – able to recover from disturbances or to adapt to environmental changes.

3. The condition of an ecosystem is, therefore, assessed with respect to ecosystem structure, function and composition which, in turn, underpins the ecological integrity of the ecosystem, and supports its capacity to supply ecosystem services. Measures of ecosystem condition may reflect multiple values and may be undertaken across a range of temporal and spatial scales. Ecosystem condition can be described by a combination of physical, chemical and biological indicators. Hence, in ecosystem accounting, the condition of an ecosystem asset is interpreted as the ensemble of multiple relevant ecosystem characteristics, which are measured by sets of variables and indicators that in turn are used to compile the accounts. The variables and indicators are selected in relation to the context and purpose of assessment, and different considerations will be relevant across natural and anthropogenic ecosystems. The ecosystem condition accounts organise the relevant data on selected ecosystem characteristics and the distance to a reference condition to provide insight into the ecological integrity of the ecosystems. Individual indicators can be aggregated to composite indices that provide a synthesis of the integrity, health or naturalness of an ecosystem asset.

4. The SEEA ecosystem condition typology (SECT) is a hierarchical typology for organizing data on ecosystem condition characteristics. By describing a meaningful ordering and coverage of characteristics, it can be used as a template for variable and indicator selection and provide a structure for aggregation. The SECT also establishes a common language to support increased comparability among different ecosystem condition studies.

5. A brief description of the SEEA-EA Ecosystem Condition Typology is presented in Table 1 below.

Table 1: SEEA EA Ecosystem Condition Typology (SECT)

	SECT Superclass	SECT class
Ecosystem condition	Abiotic ecosystem characteristics	1. Physical state characteristics (including soil structure, water availability)
		2. Chemical state characteristics (including soil nutrient levels, water quality, air pollutant concentrations)
	Biotic ecosystem characteristics	3. Compositional state characteristics (including species-based indicators)
		4. Structural state characteristics (including vegetation, biomass, food chains)
		5. Functional state characteristics (including ecosystem processes, disturbance regimes)
	Landscape level characteristics	6. Landscape and seascape characteristics (including landscape diversity, connectivity, fragmentation, embedded semi-natural elements in farmland)

6. The precise structure of ecosystem condition accounts will depend on the selected characteristics, data availability, uses of the accounts and policy applications. Ecosystem condition accounts are commonly compiled by ecosystem type because each type has distinct characteristics.

7. Given the linkages of the croplands with the local and global environment, climate regulation, food, energy and others, it is important to monitor the status of the croplands. One of the indicators for the cropland condition accounts- the fragmentation of the cropland ecosystem has been discussed in the subsequent paras. According to the SEEA-EA Ecosystem Condition Typology (SECT) for the Ecosystem Accounting, the land fragmentation – which is one of the indicator for the cropland condition accounts comes under the category of the Landscape level characteristics.

Fragmentation of Cropland

8. Land Fragmentation refers to the reduction in the size of the landholding due to distribution of land among inheritors or due to other reasons. Several reasons may be attributable to land fragmentation. For instance, in India, the process of land fragmentation has been primarily induced by the dependency of a large proportion of population on agriculture and an underdeveloped land market. Land fragmentation is a major threat to

efficient production system as small sized land holdings have reduced the economic feasibility.

9. The land fragmentation is a particular cause of concern for countries where agriculture supports the livelihood for a large share of the population. The fragmentation of land holdings generally leads to sub-optimal usage of factor inputs and this results in lower overall returns to land. Smaller farms also inhibit the use of certain types of machinery such as harvesters etc. and thus further become inefficient. Fragmentation of land is widespread in India and seem to cause low levels of agricultural productivity.

Agriculture Census in India

10. The Agriculture Census in India is the prime source of data on structure, distribution and operation of Agricultural holdings. The Agriculture Census forms part of a broader system of collection of Agricultural Statistics. It is a large scale, periodic, Government sponsored operation for collection and derivation of quantitative information about the structural aspect of agriculture in the country. The basic unit of collecting data for Agriculture Census is the `Agriculture Operational Holding' as distinct from `Ownership Holding'. This is so because the operational holding is the fundamental unit of decision making in agricultural planning.

11. The Agriculture Census in India is generally conducted at five yearly intervals. The Agriculture Census programme is carried out in three phases, with the operational holding as statistical unit at micro-level for data collection. During Phase-I of the Agriculture Census, data on primary characteristics like number and area of operational holdings by different size classes, ownership characteristics like gender, social groups and type of ownership are collected. During Phase-II of the Census, survey is conducted in selected 20 percent villages for collecting detailed data on characteristics of operational holdings such as land use, irrigation status, tenancy particulars, cropping pattern etc. Phase – III of the Census, popularly known as Input Survey, relates to collection of data on the pattern of input use by operational holdings and is conducted in 7 percent of villages in each of the State/UTs. The Input Survey is conducted after one year of the agriculture census and information is collected on the use of various inputs like fertilizers, manures, Agriculture credit, implements and machinery, seeds, livestock etc.

Gini Index of Land Concentration

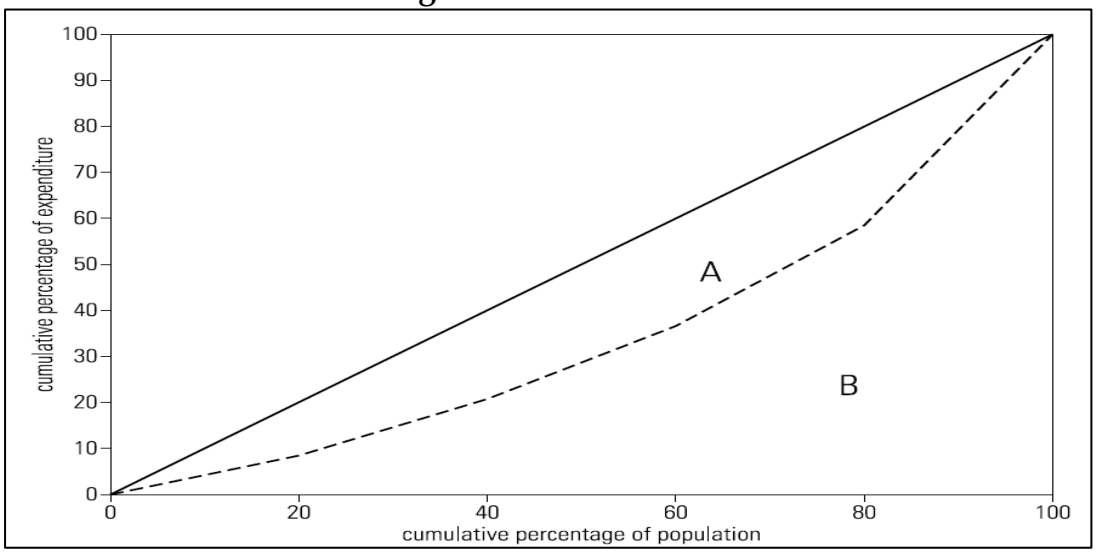
12. To bring to light, the status of fragmentation of land holdings across countries, FAO prepares and releases estimates of Gini Index of Land Concentration using information from the Agriculture Censuses conducted by different countries. The general Gini Index, a common indicator of inequality, is based on Lorenz curve which is a cumulative frequency

curve that compares the prevailing distribution with the uniform distribution representing equality. **Figure 1** gives the Lorenz curve for expenditure and here, Gini coefficient is A/(A+B) where the diagonal represents perfect equality. Formally, let x_i be a point on the x-axis, and y_i a point on the y-axis. Then,

$$Gini = 1 - \sum_{i=1}^{N} (x_i - x_{i-1}) * (y_i + y_{i-1})$$

Gini coefficient when equal to zero means perfect equality and when equals one means perfect inequality.

Figure 1: Lorenz Curve



13. The Gini Index of Land concentration can be compiled by taking the cumulative percentage of holdings (from small to large) on the horizontal axis and the cumulative percentage of area of holdings on the vertical axis. The steps describing the computation method of the Gini Index in the Indian context are discussed in the following section.

Compilation of Gini Index of Land Concentration in India

14. As per the Agriculture Census, the average size of operational holdings has decreased in India from 2.28 hectares in 1970-71 to 1.84 hectares in 1980-81, to 1.41 hectares in 1995-96 and to 1.08 hectares in 2015-16. Considering the declining trend observed in the size of agriculture holdings in the past and the prospective increase in population over time, the fragmentation of holdings is likely to continue and the average size of operational holdings is expected to further decrease in the country.

15. It is thus important to assess the status of cropland fragmentation. The assessment has been done for the years 2005-06, 2010-11 and 2015-16 by calculating Gini Index of Land Concentration using data from the Agricultural Census. The methodology and the steps for the same are as given below:

Step 1: The data on state-wise average size and the number of operational holding for different size classes can be downloaded from the website of Agriculture Census, http://agcensus.dacnet.nic.in/.

The following estimates are computed for the different size categories for each state.

Step 2: (i) The total number of holdings = sum of all operational holdings

(ii) The total operated area = (Average size of the holding* Number of holding)

Step 3: Fraction of holding = (No of operational holding/Total no of holdings)

Step 4: Compute the cumulative fraction of holdings for the different size categories of holdings.

Step 5: Fraction of area = (Average size of the holding * Number of the holding)/Total operated area.

Step 6: Compute the cumulative fraction of area for the different categories of holdings.

Step 7: Score = (Difference between Cumulative fraction of holding of two consecutive class) * (Sum of cumulative fraction of area between two consecutive class)

Step 7: Aggregate score = Sum of all the scores for the different classes.

Step 8: Gini Index of land concentration = 1-Aggregate score

16. Using the above steps, Gini Index for Land Concentration has been compiled for the States of India by using the reports of Agriculture Census conducted during 2005-06, 2010-11 and 2015-16.

17. The status of cropland fragmentation in India has been assessed at state and national levels for India using the datasets from Agriculture Census and methods prescribed in the previous paragraphs for three years – 2005-06, 2010-11 and 2015-16, synchronous with the Agriculture Census. **Table 1** below gives the estimates of Gini Index of Land Concentration at the State/UT and national level.

Table 1: Gini Index of Land Concentration

State	2005-06	2010-11	2015-16
Andhra Pradesh	0.52	0.50	0.51
Arunachal Pradesh	0.49	0.47	0.52
Assam	0.52	0.53	0.53
Bihar	0.52	0.50	0.48
Chhattisgarh	0.55	0.54	0.53
Delhi	0.55	0.55	0.52
Goa	0.75	0.56	0.64
Gujarat	0.49	0.50	0.46
Haryana	0.59	0.59	0.59
Himachal Pradesh	0.54	0.53	0.53

State	2005-06	2010-11	2015-16
Jammu & Kashmir	0.49	0.49	0.49
Jharkhand	-	0.57	0.58
Karnataka	0.52	0.50	0.52
Kerala	0.53	0.52	0.49
Madhya Pradesh	0.52	0.50	0.49
Maharashtra	0.48	0.48	0.49
Manipur	0.37	0.37	0.37
Meghalaya	0.44	0.47	0.47
Mizoram	0.34	0.36	0.37
Nagaland	0.49	0.45	0.42
Odisha	0.44	0.43	0.40
Punjab	0.45	0.46	0.44
Rajasthan	0.59	0.59	0.59
Sikkim	0.59	0.57	0.56
Tamil Nadu	0.54	0.54	0.54
Telangana	-	0.49	0.47
Tripura	0.51	0.51	0.46
Uttar Pradesh	0.49	0.49	0.49
Uttarakhand	0.52	0.48	0.48
West Bengal	0.40	0.39	0.39
Andaman and Nicobar Islands	0.48	0.47	0.47
Chandigarh	0.56	0.54	0.55
Dadra and Nagar Haveli	0.50	0.50	0.49
Daman and Diu	0.55	0.51	0.49
Lakshadweep	0.48	0.48	0.45
Puducherry	0.61	0.51	0.56
All India	0.59	0.58	0.57

18. The Gini Index of Land Concentration can be computed at the District levels as well using the District tables also available from the Agriculture Census and following Steps 1 to 8 as mentioned above.

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