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Aryama Bharti
Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyala, Raipur, Chhattisgarh, India

MR Chandrakar
Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyala, Raipur, Chhattisgarh, India

Corresponding Author:
Aryama Bharti
Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyala, Raipur, Chhattisgarh, India

Estimating agricultural sustainability in Chhattisgarh using sustainable livelihood security index

Aryama Bharti and MR Chandrakar

Abstract
The paper has estimated agricultural sustainability in Chhattisgarh by computing Sustainable Livelihood Security Index (SLSI) for 27 districts of the state using secondary data on various indicators under the ecology, economy and Social equity heads for the years 2017-2018. The study has found that in the year 2017, the district Rajnandgaon (0.718) ranked first in SLSI, while Narayanpur (0.164) ranked the last. The paper has suggested some measures for agricultural sustainability in the state in the years to come.

Keywords: Sustainable agriculture, livelihood security, sustainability, livelihood security index, Chhattisgarh

Introduction
The origin of sustainability in development can be traced to the first UN conference on human development held in 1972 at Stockholm, when global consciousness on ecology, environment and poverty emerged. The sustainable development implies development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is a symbiotic relation between humans and natural systems, and compatibility between ecology, economy and equity. Agriculture is one of the most aggressively managed ecosystems, and it has impact on global food system. Therefore, environment-friendly agriculture is a must for sustainability of humans and society. The sustainable agriculture can be considered as food production that integrates the goals of environmental health, economic efficiency and social equity (Sajjad *et al.*, 2014) [5].

Agriculture is the main occupation in developing countries like India, where the majority of rural poor depend on it for income and livelihood. Therefore, sustainability of agriculture cannot be defined in isolation to the issue of livelihoods. Livelihood security means secured ownership of, or access to, resources and income-earning activities, including reserves and assets to offset risks, ease shocks and meet contingencies (Acharya, 2006) [1]. According to Chambers and Conway (1992) [2], a livelihood is sustainable when it can cope with and recover from the stress and shocks, maintain its capability and assets, and provide sustainable livelihood opportunities for the next generation.

The inter-related dimensions of sustainability are ecology, economics and equity; therefore, to ensure sustainable development ecological security, economic efficiency and social equity are must. Ecological security is essential to preserve and develop the resource base of the economy. Economic efficiency provides guidance to use of resources (human and capital) under present technological conditions and social equity ensures a broad-based distribution of economic benefits both at present and in future, in the form of secured livelihoods, especially for socially and economically vulnerable groups.

Sustainable Livelihood Security (SLS), according to Swaminathan (1991) [7] is livelihood options that are ecologically secure, economically efficient and socially equitable. It implies the protection or assurance of the means of livelihood for the masses not only at present but also in future. Sustainable Livelihood Security Index (SLSI) can help to identify whether necessary conditions for sustainable development exist in a given region/ecosystem or not. The main objective of the paper was to estimate agricultural sustainability in the state of Chhattisgarh using Sustainable Livelihood Security Index and examine variations in it among different districts of the state with time 2017-18.

Data and Methodology
A number of factors affect the sustainable development of an area, hence relevant and maximum available indicators were used in this study. The Sustainable Livelihood Security Index (SLSI) was calculated for 27 districts of Chhattisgarh. The district-wise data were collected compared for the years 2017-18.

The secondary data were collected from various published sources of Government of Chhattisgarh; Directorate of Economics and Statistics, Chhattisgarh, Directorate of Agriculture, Directorate of Animal Husbandry, National Dairy Development Board (NDDB), Statistical Abstracts of Chhattisgarh State, Health Statistics, Directorate of Rural Development, etc. The variables given below were grouped under the ecology, economy and equity heads and data were collected under these heads.

Ecological Security Indicators

The factors like population density, population growth, livestock density, area under forest, etc. were used to estimate the ecological security. The variables population density and population growth were selected as they are representative of the extent of human pressure on overall ecological security. Forest play a vital role in maintaining ecological balance and contribute significantly to economy. Both the economic and ecological functions of forest help people in sustaining their livelihoods. So, area under forest cover was selected for ensuring ecological security. To assess agricultural sustainability in the context of ecological security, net irrigated area variables were selected. The livestock sector plays an important role in the socio-economic development of a nation. Therefore, livestock density was selected in view of its capacity to reflect the extent of animal pressure on the overall resources of environment.

The selected variables are enumerated below. The '+' and '–' signs indicate the positive impact and negative impact, respectively of the variables.

- Population density (per km2) (-)
- Proportion of geographical area under forest (%) (+)
- Livestock density (per km2) (+)
- Net irrigated area (ha) (+)

Economic Efficiency Indicators

The economic efficiency is represented by the variables like total foodgrain yield, total milk production, net sown area, etc. The foodgrain and milk yields not only capture the physical performance of soil productivity, biochemical technologies and yield of milch animals but also the potential for overall food and nutritional security of the districts. The net sown area represents the comparable agricultural land base for farm-based production systems. The economic efficiency indicators along with signs are listed below:

• Total food grain yield (kg/ha) (+)
• Total milk production (tonne) (+)
• Net sown area (ha) (+)
• Unemployment (+)

Social Equity Indicators

The social equity is evaluated by variables like percentage of population below poverty line, literacy rate, etc. The female literacy rate plays a vital role in the process of women empowerment and national development. Village electrification is an integral variable as lack of reliable electric supply hampers the growth impulses in different sectors of the economy. The number primary health centers show the access to basic amenities to people in the area. The selected indicator variables along with signs are listed below:

- Literacy rate (%) (+)
- Female literacy rate (%) (+)
- Village electrified (%) (+)
- Number of primary health centers (per lakh population) (+)

The Sustainable Livelihood Security Index **(**SLSI**)** was computed based on three indices, *viz***.** Ecological Security Index (ESI), Economic Efficiency Index (EEI) and Social Equity Index (SEI) using the ratio methodology given below:

$$SLSI_{ijk} = \frac{X_{ijk} - \min_k X_{ijk}}{\max_k X_{ijk} - \min_k X_{ijk}} \quad (1)$$

$$SLSI_{ijk} = \frac{\max_k X_{ijk} - X_{ijk}}{\max_k X_{ijk} - \min_k X_{ijk}} \quad (2)$$

Where,
i = Variables (1, 2, 3 ….i),
j = Components (1, 2, 3…j),
k = Districts 1, 2, 3…k),
X_{ijk} = Value of the i^{th} variable, j^{th} component of k^{th} district, and

$SLSI_{ijk}$ = Value of index for the i^{th} variable representing the j^{th} component of the SLSI of k^{th} district, respectively.

Equation (1) is applicable to variables having positive implications for SLSI and Equation (2) is for variables having negative implications. The numerators in Equation (1) measure the extent by which the k^{th} district does better in the i^{th} variable representing the j^{th} component of its SLSI as compared to the region(s) showing worst performance. The denominator is the range, i.e. the difference between maximum and minimum values of a given variable across districts.

After calculating $SLSI_{ijk}$ for all variables, the indices for various components of SLSI were calculated as a simple mean of the three indices of their respective variables, i.e.

$$SLSI_{jk} = \frac{\sum_{i=1}^{I} SLSI_{ijk}}{I} \quad (3)$$

The three component indices of SLSI, *viz*. ESI, EEI and SEI were calculated by taking the equal weights of the indices of the respective representative variables. The SLSI, which is a composite index, was calculated by taking the arithmetic mean of its component indices. The values vary between 0 and 1. A value close to zero shows low level of sustainability and value close to 1 denotes high level of sustainability.

Results and Discussion

Sustainable Livelihood Security Index, 2001

The SLSI with its three component indices for different districts of Chhattisgarh is presented in Table 1. In the year 2017, Rajnandgaon had the highest ranking in SLSI (0.718), followed by Janjgir- Champa (0.674) and Raipur (0.669). In this year, all these districts fared well in all the three dimensions (ecology, economic and social) of sustainability. But, their ranking was better in equity and economy than in ecology, as these districts were better in terms of provision of civic amenities and had better economic efficiency owing to better milk and foodgrain production. The low ranking districts in the state were Narayanpur, Sukma and Dantewada having an index value of 0.164, 0.211 and 0.213, respectively. These districts lagged behind in terms of equity and economy but had comparatively better ecological conditions than high ranking districts. The development in the state was taking a toll on ecological security as all high ranking districts did not hold high ESI values.

Conclusions

The Government of Chhattisgarh has played an important role in developing infrastructure like irrigation, power, roads, etc. Chhattisgarh has achieved significant strides in agriculture through modernization, diversification, good infrastructure for production and marketing. The huge public investment on agricultural development, industrial development, irrigation projects, improved crop varieties, extension services, dissemination of technologies through Krushi Mahotsav, Kisan gosthi, Kisan melas, on-campus and off-campus trainings, issue of Soil Health Cards have all been the positive steps towards increasing agricultural productivity in the state. The state has achieved double digit agricultural growth, but this growth needs to be sustainable in the years to come. Evidently, regional disparity exists among districts of Chhattisgarh in terms of ecology, economy and equity. Over the years, none of the districts has been found efficient in all the three indicators, especially ecological indicators which show continuance of huge pressure on natural resources. Therefore, the ecological resources need to be used adequately. The tribal districts of the state lag behind in provision of better civic amenities and hence efforts must be directed towards increasing the economy and social equity of these districts.

Policy Measures

The government should focus on dissemination of micro-irrigation, high-value crops, market institutions and extension and information service institutions. Efficient water management through micro-irrigation systems, reducing wide fluctuations in agricultural productivity and prices, checking distress sales and rising cultivation cost, increasing agricultural exports and dissemination of modern technologies and agricultural innovations are some of the important sectors that need immediate attention of the government.

Table 1: District wise Sustainable Livelihood Security Index of Chhattisgarh for the year 2017

Sustainable livelihood security index (2017)									
S. No.	**District**	**Esi**	**Rank**	**Eei**	**Rank**	**Sei**	**Rank**	**Slsi**	**Rank**
1	Koriya	0.474	19	0.366	13	0.537	14	0.459	14
2	Surguja	0.434	22	0.215	22	0.427	20	0.358	22
3	Jashpur	0.493	15	0.35	14	0.578	13	0.473	13
4	Raigarh	0.47	20	0.628	6	0.838	2	0.645	5
5	Korba	0.44	21	0.319	16	0.62	9	0.459	14
6	J-chapa	0.594	1	0.731	3	0.699	4	0.674	2
7	Bilaspur	0.504	11	0.698	4	0.759	3	0.653	4
8	Kawardha	0.537	7	0.344	15	0.47	17	0.45	16
9	Rajnandgaon	0.524	10	0.751	2	0.881	1	0.718	1
10	Durg	0.363	26	0.637	5	0.61	11	0.536	9
11	Raipur	0.589	2	0.767	1	0.653	6	0.669	3
12	Mahasamund	0.526	9	0.555	8	0.641	8	0.574	6
13	Dhamtari	0.585	4	0.449	9	0.615	10	0.549	8
14	Kanker	0.49	16	0.373	12	0.651	7	0.504	11
15	Bastar	0.485	18	0.289	19	0.42	21	0.398	20
16	Dantewada	0.383	25	0.087	26	0.17	24	0.213	25
17	Narayanpur	0.328	27	0.009	27	0.155	25	0.164	27
18	Bijapur	0.501	13	0.093	25	0.123	26	0.239	24
19	Balodabazar	0.537	7	0.562	7	0.61	11	0.569	7
20	Gariyaband	0.428	23	0.291	18	0.465	19	0.394	21
21	Mungeli	0.415	24	0.309	17	0.476	16	0.4	19
22	Balod	0.501	13	0.427	10	0.67	5	0.532	10
23	Bemetera	0.549	6	0.423	11	0.499	15	0.49	12
24	Kondagaon	0.502	12	0.187	23	0.337	23	0.342	23
25	Sukma	0.489	17	0.126	24	0.02	27	0.211	26
26	Balrampur	0.586	3	0.255	21	0.414	22	0.418	18
27	Surajpur	0.557	5	0.276	20	0.468	18	0.433	17

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