Sustainability of agriculture in Amravati district of Vidarbha, Maharashtra

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ABSTRACT

In this study, an attempt has been made to measure the sustainability of agriculture with the help of various indicators of sustainability in Amravati district of Vidarbha region. The study was based on the secondary data collected from various government publications pertaining to a period of 26 years *i.e.* from 1980-81 to 2005-06. The result showed that the sustainability index of Amravati district developed through principal component analysis which was seen declining over the years. Higher number of sustainability index represents higher sustainability whereas, lower number represents lower sustainability, which indicates that, the Amravati agriculture is tending towards unsustainabilty.

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INTRODUCTION

Agriculture is a complex of processes taking place within biophysical, socio-economic and political constraints, which control the sustainability of the farming activities (Yunlong and Smit, 1994). The concept of sustainable agriculture combines characteristics such as long term maintenance of natural systems, optimal production with minimum input, adequate income per farming unit, fulfillment of basic food needs, and provision for the demands and necessities of rural families and communities. The concept of sustainable agriculture is mostly aimed to promote environmental, economic and social harmony. The most relevant issue today is to design suitable technologies, as well as compatible strategies from the social, economic and ecological viewpoints that will bring about the necessary behavioral changes to achieve the objectives of sustainable agriculture. Sustainable agriculture is defined as a practice that meets current and long-term needs for food, fibre, and other related needs of society while maximizing net benefits through conservation of resources to maintain other ecosystem services and functions, and long-term human development. It emphasizes multidimensional (economic, environment and social) goals for addressing the problems of sustainable agricultural development. Thus, while green-revolution agriculture addressed mainly productivity issues, sustainable agriculture must not only address productivity issues more intensively, but do so keeping multidimensional (economic, environmental and social) concerns of sustainability in sight.

Sustainability is a concept and cannot be measured directly. Appropriate indicators must be selected to determine levels and duration of sustainability (Zinck and Farshad, 1995). An indicator of sustainability is a variable that allows describing and monitoring the processes, states the tendencies of systems at the farm, regional, national or worldwide levels. It must be sensitive to temporal and spatial changes, predictable, measurable and interactive. They possess multidimensional attributes– economic, environmental and social. Indicators can be meaningfully integrated into an aggregated index. They allow integrated assessments after taking into account all information provided by indicators.

Amravati is one of the cotton growing

districts in Vidarbha. For most farmers, in this region, cotton is the primary cash crop and therefore the principal source of income. However, this has turned out to be most unremunerative in the last decade. This district has been hard-hit by plunging cotton prices, the rising cost of fertilizer and other inputs and mounting debt. These woes have been aggravated especially in the past year, by drought. Repeated crop failures, inability to meet the rising cost of cultivation and indebtedness seem to create a situation that forces farmers to commit suicide. However, not all farmers facing these conditions commit suicide – it is only those who seem to have felt that they have exhausted all avenues of securing support, have taken their lives (Anonymous, 2005).

These suicides point to a greater crisis in the agrarian system as a whole where, the suicide is a symptom of a greater malaise that threatens millions of farmers and landless agricultural laborers. This raises the issue of sustainability in Amravati district. Therefore, the present study has been largely focused on agricultural in Amravati district, where the life of a large section of the population centres on agriculture. The various indictors of sustainability were selected as per the data availability and the study was restricted to Amravati district of Vidarbha region. The objective of this study was aimed to investigate sustainability of agriculture in Amravati district of Vidarbha with the help of various indicators of sustainability and to develop sustainability Index of Amravati district.

METHODOLOGY

The present study was aimed to study the sustainability of agriculture in Amravati district of Vidarbha. Indicators of sustainability of Amravati have been constructed for the period 1980-81 to 2005-06 utilizing the data available through different sources. The study was limited to the principal crops namely cotton, *Kharif* jowar, soybean, pigeonpea, chickpea and sunflower cultivated in Amravati district of Vidarbha. Data pertaining to area, productivity, population, agricultural population, weather, irrigation, area under high yielding varieties were collected from various Government publications of Maharashtra. The data for computation of indicators cost-benefit ratio for selected crops were adopted from the records of Agricultural Prices Cell, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Indicators of sustainability of Amravati district:

The various indicators of sustainability of Amravati district were as follows:

- Index of surface percentage of crops
- Crop yield
- Cost-benefit ratio
- Irrigated land / irrigable land
- Agricultural population / Total population
- Per capita production of foodgrains
- Area under high yielding varieties
- Cropping intensity
- Availability of land per farmer
- Rainfall
- Analytical framework

Principal component analysis:

Principal component analysis (PCA), a popular multivariate technique, is mainly used to reduce the dimensionality of p multi-attributes to two or three dimensions. PCA summarizes the variation in a correlated multi-attribute to a set of a few uncorrelated components, each of which is a particular linear combination of the original variables. The extracted uncorrelated components are called principal components (PC) and are estimated from the eigenvectors of the covariance or correlation matrix of the original variables. Therefore, the objective of PCA is to achieve parsimony and reduce dimensionality by extracting the smallest number components that account for most of the variation in the original multivariate data to summarize the data with little loss of information.

Principal component analysis can be performed either on the original variables, or their deviations from the means $x_j = X_j - X_j$ or the standardized variables (measured as the deviations of the X_j's from the means and subsequently divided by the standard deviation);

$$\mathbf{Z_j = x_j / S_{xj}}$$

Principal components satisfy two conditions:

– The principal components are uncorrelated (orthogonal) and

– the first principal component P_1 absorbs and accounts for the maximum possible proportion of the total variation in the set of all X's, the second principal component absorbs the maximum of the remaining variation in the X's and so on. In our study, a required number of components that explains at least 85 per cent of total variation were chosen for developing composite Index. A composite index was derived by taking sum of weighted PCA scores with eigen values as weights.

RESULTS AND ANALYSIS

The findings of the present study have been discussed

in details as under :

Performance of Indicators of Sustainability in Amravati district:

The triennium averages of various indicators of sustainability of Amravati district during different segments of time periods from 1980-81 to 2005-06 is shown in Table 1. It can be seen that the Index of Surface Percentage of Crops of Amravati district of Vidarbha region declined by 20 per cent during 1980-81 to 2005-06.

It can also be seen from Table 1, that during the period 1980-81 to 2005-06, the yields of major crops had observed a spectacular growth. The yield of sunflower has increased by 345.03 per cent from 1980-81 to 2005-06. The yield of cotton had increased by 111.24 per cent during the same period. The yield of chickpea, pigeonpea and *Kharif* jowar had increased by 48.47 per cent, 18.68 per cent and 2.25 per cent, respectively. Soybean was an introduced crop in the 1990s, the yield of which increased by 111.51 per cent from 1990-91 to 2005-06.

Regarding profitability of crops were concerned, the cost-benefit ratio of sunflower increased by 126.32 per cent during the period 1980-81 to 2005-06. The cost-benefit ratio of soybean increased by 14.68 per cent whereas, the cost-benefit ratio of *Kharif* jowar, cotton, chickpea and pigeonpea decreased by 31.79 per cent, 18.32 per cent, 14.18 per cent and 8.82 per cent, respectively during the same period.

The ratio of irrigated land to irrigable land, area under high yielding varieties and cropping intensity increased by 44.44 per cent, 91.58 per cent and 25.60 per cent, respectively. Whereas, ratio of agricultural population to total population, per capita production of foodgrains, availability of land per farmer and rainfall decreased by 19.35 per cent, 34.70 per cent, 36.90 per cent and 17.06 per cent, respectively.

Development of sustainability index:

Table 2 presents the eigen values and cumulative percentage for the indicators of sustainability. It can be seen from the table that the component analysis produces components in descending order of their importance *i.e.*, the first component explains the maximum amount of variation, and the last component the minimum. The first component only accounts for 42 per cent of variation. The second component explains 55 per cent of variation. It takes seventh components to produce 86 per cent of

Table 1 : Triennium average of indicators of sustainability and related agricultural development in Amravati

Sr. No.	Indicators of sustainability	Unit	1980-83	1990-92	2000-02	2003-05	Percentage increase (+)/ decrease (-)
1.	Index of surface percentage of crops	-	0.5	0.5	0.38	0.4	(-)20
2.	Crop yield in cotton	Kg/ha	64.50	103	101.75	136.25	111.24
3.	Crop yield in *Kharif* jowar	Kg/ha	1268.00	1251	1364.25	1296.50	2.25
4.	Crop yield in pigeonpea	Kg/ha	733.50	784.5	897.75	870.50	18.68
5.	Crop yield in chickpea	Kg/ha	383.75	592.25	737.75	739.25	48.47
6.	Crop yield in soybean	Kg/ha	-	358.5	1195.25	758.25	111.51
7.	Crop yield in sunflower	Kg/ha	497.50	1254.25	2059.50	2214.00	345.03
8.	Cost-benefit ratio of cotton	-	1.31	0.99	0.93	1.07	(-)18.32
9.	Cost-benefit ratio of Kh. jowar	-	1.51	1.16	0.98	1.03	(-)31.79
10.	Cost-benefit ratio of pigeonpea	-	1.36	1.34	1.30	1.24	(-)8.82
11.	Cost-benefit ratio of chickpea	-	1.34	1.28	1.08	1.15	(-)14.18
12.	Cost-benefit ratio of soybean	-	1.09	1.32	1.11	1.25	14.68
13.	Cost-benefit ratio of sunflower	-	0.57	0.92	1.25	1.29	126.32
14.	Irrigated land / Irrigable land	-	0.18	0.21	0.26	0.26	44.44
15.	Agricultural population / Total population	-	0.31	0.31	0.28	0.25	(-)19.35
16.	Per capita production of foodgrains	Kg/person/annum	190.63	204.98	137.58	124.48	(-)34.70
17.	Area under high yielding varieties	Per cent	22.70	19.13	43.28	43.49	91.58
18.	Cropping intensity	Per cent	108.63	116.35	137.54	136.44	25.60
19.	Availability of land per farmer	Ha.	2.71	2.29	1.79	1.71	(-)36.90
20.	Rainfall	mm	858.33	870.18	878.35	711.91	(-)17.06

Table 2: Result of principal component analysis

Set of components	Eigen value	Cumulative percentage
1	8.4938	0.425
2	2.4700	0.548
3	1.7570	0.636
4	1.4111	0.707
5	1.2777	0.770
6	0.9922	0.820
7	0.8623	0.863
8	0.5847	0.892
9	0.5167	0.918
10	0.4537	0.941
11	0.3377	0.958
12	0.2889	0.972
13	0.2110	0.983
14	0.1132	0.989
15	0.0731	0.992
16	0.0637	0.995
17	0.0542	0.998
18	0.0278	0.999
19	0.0070	1.000
20	0.0042	1.000

variation, and another two for 92 per cent variation. The first seven components account for a sizeable amount of variation *i.e.*, 86 per cent thus succeeded in effectively reducing the dimension of the problem. The subsequent components contribute very little.

Sustainability index:

Table 3 presents the sustainability index of Amravati district derived from composite index, which provided a composite profile of regional agricultural stewardship based on a compilation of 20 indicators that derived from 26 years of data. It was observed that the results of the principle component analysis were astonishingly clear and appealing from an agricultural perspective. The numerical scores ranging from -0.326 to 0.316 which represented the Sustainability Index, obtained through principle component analysis. Further, it was observed that the index obtained through the principle component analysis was seen declining. Higher numbers represented higher sustainability whereas, lower number represented lower sustainability.

The higher sustainability was observed in the year 1991-92 (0.316) followed by 1986-87 (0.263) and 1995-96 (0.234). The lower sustainability was observed in the year 1998-99 (-0.326). The higher a year's sustainability index, the better positioned it is to maintain favourable agricultural conditions into the future.

Table 3: Sustainability index of Amravati district

Years	Sustainability index
1980-81	0.191
1981-82	0.016
1982-83	0.120
1983-84	0.094
1984-85	0.150
1985-86	0.035
1986-87	0.263
1987-88	0.091
1988-89	0.171
1989-90	0.147
1990-91	-0.139
1991-92	0.316
1992-93	-0.149
1993-94	-0.516
1994-95	-0.150
1995-96	0.234
1996-97	0.107
1997-98	-0.185
1998-99	-0.326
1999-00	0.010
2000-01	-0.210
2001-02	-0.154
2002-03	-0.243
2003-04	-0.022
2004-05	-0.193
2005-06	-1.162

The sustainability index was a measure of overall progress towards agricultural sustainability developed for 26 years. The main goal of this index was to take sustainability into account in the measurement of the agricultural development level. It represented a first step towards a more analytically driven approach to agricultural decision making. The sustainability index enables to identify the areas of success or failures. It offered a small step toward a more vigorous and quantitative approach to agricultural decision making.

Conclusion:

From this study, it is concluded that, the sustainability index of Amravati district developed through principal component analysis was seen declining over the years. Higher number of sustainability index represents higher sustainability whereas, lower number represents lower sustainability, which indicates that, the Amravati agriculture is tending towards unsustainabilty.

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