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Development of Sustainability index of Sugarcane cultivation and its measurement

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ABSTRACT

The study was conducted in Visakhapatnam district of Andhra Pradesh where highest acreage under sugarcane cultivation in the state with a sample of 240 farmers. The scale to measure the sustainability was developed with 11 components of Sugarcane cultivation and sustainability was measured separately for rainfed and irrigated farmers. The results indicated that the irrigated farmers able to maintain more sustainability than rainfed farmers.

Key words : Sugarcane Cultivation, Sustainability index.

Everyone expects development without destruction, but unfortunately very often it happens the other way. "Agriculture" as practiced in the recent 4 to 5 decades is considered as a serious polluter of environment. In the anxiety of increasing food production for ever increasing population of the country during the past 50 years, least attention had been given to production environment. This kind of agriculture is associated with decline in soil productivity, deterioration of the environment quality, reduced profitability and ultimately threatening the human and animal health.

Sustainable agriculture requires attention to resource conserving technologies and practices, local groups and institutions and external organizations working in partnership with local people believing sustainability in agricultural production and conservation of natural resources are considered to be topics of major concern among the scientific community. Sustainable agriculture is not new to Indian farmers, because the farming practices by one farmer for centuries was "Sustainable Agriculture." With this Background the study was conducted with an objective to develop an index to measure the sustainability of sugarcane cultivation and its measurement.

The results of the study indicate that most of the farmers (65.84%) posses medium sustainability index followed by low and high category. The results also indicate that the irrigated farmers are slightly high in sustainability than the rainfed farmers because of assurance of irrigation water and other inputs.

MATERIAL AND METHODS

The ex-post facto research design was used for the study, since the variables chosen for the investigation had already occurred.

Visakhapatnam district of Andhra Pradesh state was chosen for the study purposively for its highest acreage under sugarcane cultivation and one of the Sugarcane research station is located in this district. Six mandals wereselected viz. Anakapalle, Munagapaka,Kasimkota, Chodavaram, Cheedikada, Yellamanchili by using simple random sampling method.

This study was conducted in 12 selected villages with a sample of 240 farmers, in which 120 were rainfed and 120 were irrigated sugarcane farmers. With the help of available literature and discussions held with the experts, a list of components, purported to be the indicators of sustainable sugarcane cultivation were prepared.

The components were then scrutinized for their amenability for operationalisation measurement and possibility of eliciting data from farmers. Later on, components were retained as essentials of sustainable sugarcane cultivation.

The list thus prepared was subjected to relevancy rating of judges The judges were asked to indicate their response on 3-point relevancy continuum viz., 'most relevant,' 'relevant,' 'some what relevant.'

The operational definition for sustainability of sugarcane cultivation and its component were supplied to judges to orient them towards the broader concept of sustainable agriculture.

In all, judges responded to the cell relevancy coefficient of 1st component (RCi) was worked by dividing Total score of all the judges on ith components with Maximum score on the continuum x Total number of judges and expressed in ratio.

Those components with the relevancy coefficient of 07 above were selected for the development of index.

In order to compute the scale value for each of the selected indicators, their relative importance to the sustainable sugarcane cultivation were obtained by experts rating.

The 11 components were presented to 25 selected experts and were asked to rank them in the relative importance by giving 1st rank to most important component and 9th rank to least important components. Using the Guilford (1954) method, ranks were concerted into rank values, centile values were worked out followed by "c" values and the scale values by using the formula.

$$Rc = 2.3757\ RI - 7.01$$

Scale values of each of the components are as follows. Soil environment level - 8.07, Eco-system management - 5.32, Input use index - 4.78, Information self-reliancy - 4.78, Input self sufficiency - 4.78, Integrated nutrient management - 4.78, Integrated post management - 10.04, Land productivity - 10.43, Input productivity -7.05, Crop diversity - 4.78, Water Management - 6.58. These scale values have been used to arrive at index of sustainability of sugarcane cultivation for each farmer.

Measurement of the components of sustainability of sugarcane cultivation.

Sustainability of sugarcane cultivation is process by which farmer manages the soil and water, relying mainly on on-farm resources to enhance productivity without affecting the production environment.

The scoring procedure followed by Chandra Gowda (1996) was used. However, the detailed measurements were given here:

I) Soil Environment level:

Soil environment level was operationalised as the extent of adoption of different soil and water conservation to protect the fertility level of soil.

Under this indicator four main components were identified by consulting with agronomists and soil scientists viz. recycling of farm produce and farm water, soil conservation measures, water conservation measures and vermi-culture. For measuring this indicator, 10 statements in two point continuum were prepared and used in collection of information. The soil environment level of each farmer had been worked out by dividing Actual score obtained with Maximum possible score in percentage.

II) Eco-system management.

Ecosystem management was operationalised as the extent to which the farmers adopt the different biomass production practices to maintain the congenial eco-system.

After consultation with the experts, the components have been identified. The biomass production practices identified and their weightage as per the judge's opinion are as follows Food crops cover – 1, Oilseed and other field crops-2, Fodder crops cover-3, Horticultural crops cover-4, Agro-forestry cover-5.

The relevant questions were developed and the data were collected on the aspects. The cumulative score of all the items were worked out and used in calculating the eco-system management index of such farmer by dividing Cumulative score with Maximum possible score and expressed in ratio.

III) Input use

Input use index was operationalized as the level of adoption of the production inputs for the crops grown by the farmers as against the recommended level to sustain the crop production. Under this indicator, the components identified were use of organic manure, green manuring, fertilizer application, use of seed material and bio-fertilizer application after thorough discussion with the experts in the field.

The questions on those aspects were developed and used in the collection of data. For each component, the farmers assigned three score for response as per "recommendation" , two score for deviation from recommendation and one score for 'non use.' The input use index was calculated by dividing Cumulative score with Maximum possible score and expressed in ratio.

IV) Information self reliance:

Information self-reliance was operationalised as the ability of the farmer to possess information required for successful sugarcane farming and to rely upon that at the time of decision making.

Information self-reliancy was measured on a 3 point continuum of reliancy -dependency ranging

from self, self and others and others with a score of 3, 2 and 1 respectively. The information self reliant index was obtained by dividing Actual Score with Possible score and expressed in percentage.

V) Input Self sufficiency:

Input self-sufficiency was operationalised as the extent to which farmer was able to meet the input requirement of sugarcane growing from own resources than the purchased inputs. It was taken as the ratio of value of owned inputs to the total value of inputs used in sugarcane farming. The value of inputs was worked out at the prevailing rates in that area at the time of data collection. The input self-sufficiency Index (ISSI) was calculated by dividing value of owned inputs with total value of inputs and expressed in percentage.

Theoretically, an ISSI value of "o" indicates that the farmer was completely dependent on external inputs and a value of 100 would indicate a farmer who was completely dependent on owned inputs.

VI) Integrated nutrient management.

Integrated nutrient management was operationalised as application of right quantity of organic and inorganic fertilizers and amendments to soil at a proper time, method and combination aimed at deriving maximum benefits and causing minimum damage to the resource base.

Keeping the operational definition in mind, a list of questions related to nutrient management was prepared. Maximum care was taken to cover all the aspects of nutrient management in sugarcane. The score of 1 for Last year, 2 for Last season, 3 for Present season and 0 for Non adoption

a) Organic manuring

Adoption of organic practices were studied as per recommendation and deviation from the recommendation and a score of 2 was given for adoption as per recommendation and 1 for deviation in adoption**.** The 6 components studied are Quantity of FYM or compost, Time of application, Method of application, Application of green manure, Time of application of green manure, and Quantity of green manure

b) Inorganic manuring

Adoption of inorganic manuring was studied with 6 components viz. first three components are application of Nitrogen, Phosporous, and potassium. For this a score of 1 was given for application each nutrient and 0 for non application. Their application as per recommendation or with deviation, method of application and distribution , for these three components 2 score for adoption as per recommendation and 1 for adoption with deviation.

Integrated nutrient management index for an individual farmer was worked out by dividing the actual score with possible maximum score and expressed in percentage.

VII) Integrated pest management.

Integrated pest management was operationalised as the management of pests, diseases and weeds by using preventive and curative measures through judicious combination of cultural, mechanical, biological and chemical means.

The scoring procedure was done as given below.

a) Prophylactic measures

1. Treatments of setts with hot water at 52°C for 30 minutes Yes 1 No 0

2. Spray of chemicals before appearing the pests and diseases? Yes 1 No 0

Curative measures.

The management measures on pest, disease and weed management were studied on three point continnum viz. As per recommendation, deviation from recommendation, and non adoption of control measure and scores of 3,2,1 were given respectively**.** The IPM index was worked out by dividing Actual score with Maximum Possible score and expressed in percentage.

VIII) Land Productivity:

Land productivity was operationalised as yield per unit area, expressed in terms of tons/ha, Land productivity was taken as the average of the past 3 crops to give weightage to productivity over a period of time. The Land productivity was calculated by dividing the total quantity of sugarcane produced from the last three crops (tons) with Total area under sugarcane during previous three crops (ha) and expressed in ratio.

IX) Input Productivity:

Input productivity was considered as output per unit of input used. It was expressed as the ratio of gross output to the total variable cost.

X) Crop diversity:

Using diversity of crops harvested as an indicator of sustainability and the production function. Thus, the crop diversity was operationalised as the diversification of crops in the area, genetic diversity within the crop, use of nitrogen fixing crops/trees, raising green manure crops etc. in order to deriving maximum benefits and causing minimum damage to the resource base.

Keeping the operational definition in mind a list of questions related to the components of crop diversity was prepared. Maximum care was taken to cover all the aspects of crop diversity. Structured questions were administered on three point continuum and the score of each farmer was arrived. Each component was given the score of three for "as per recommendation," two for 'deviation from recommendation' and one for 'no diversity."

XI Water management.

Water management was operationalised as the application of practices to obtain added benefits from rainfall and water flow through irrigation for crop production with a proper drainage to keep the soil health intact.

For each component farmers were assigned one score for 'yes' and zero score for 'no.

Water management index (WMI) was worked out by dividing Actual score with Possible score and expressed in percentage. The mean and standard deviation were calculated and the farmers were categorized in to low, medium and high categories in aspect of waer management.

Computation of sustainability Index:

The eleven indicators have been measured and expressed in different units. Hence, all the values were converted into unit values by using simple range and variability as given below.

$$Uij = \frac{Yij - Min\ Yj}{Max.\ Yj - Min\ Yj}$$

Where,

Yij = Value of the ith respondent on jth component
Min Yj = Min score on the jth component
Max. Yj = Max, score on the jth component
Uij = Unit value of ith respondent on jth component.

These unit values ranged from 0 to 1, when Yij is minimum, unit value is 0 and Yij is maximum, unit value is 1. Then, these unit values of each respondent were multiplied respective component scale values. Summed up, divided by total scale value and multiplied by 100 to get sustainability index for each respondent.

$$\text{Sustainability index} = \frac{Uij\ Jj}{\text{Total scale value}} \times 100$$

Where,

Uij = Unit value of the ith respondent on jth component
Sj = Scale value of Jth component
Total scale value = Some of the scale values of all the components.

After obtaining score, the respondents were categorized into 3 groups based on mean and S.D. as follows:

RESULTS AND DISCUSSION

The sustainability index was measured by using the above scale. The distribution of farmers according to their level of sustainability of sugarcane cultivation.

It is evident from the Table 1 that majority (65.84%) of the farmers were under medium sustainability level, followed by low (19.16%) and high (15.00%) sustainability level. This is because farmers are oriented towards the sustainability index and at the same time most of the farmers are not able to take high risk in adoption of organic management practices rather they used in combination with inorganic management practices.

The sustainability index was also calculated separately for both rainfed and irrigated farmers and the results are presented as below

The result from the table 2 indicate that there is a significant difference between the irrigated and rainfed farmers in maintaining sustainability in sugar cane cultivation. The irrigated farmers had a mean sustainability of 56.91 which is significantly higher than the irrigated farmers (42.43). the table also indicate that percentage of farmers in high and medium sustainability are more in irrigated than the rainfed farmers. This may be because of assured sources of irrigation, access to inputs and their socio economic status.

Table 1. Distribution of farmers according to their level of sustainability of sugarcane cultivation
(n= 240)

S.No.	Category	Respondents	
		Frequency	Percentage
1	Low sustainability index	46	19.16
2	Medium sustainability	158	65.84
3	High sustainability	36	15.00
	Total	240	100.00

Mean= 49.67 S.D= 11.25

Table 2. Distribution of rainfed and irrigated farmers according to their level of sustainability of Sugarcane cultivation.
(n= 240)

S.No.	Category	Irrigated farmers		Rainfed farmers	
		Frequency	Percentage	Frequency	Percentage
1	Low	15	12.50	26	21.66
2	Medium	86	71.66	80	66.66
3	High	19	15.84	14	11.68
	Total	120	100.00	120	100.00

Mean= 56.91 S.D= 8.80 Mean=42.43 S.D=8.40

Conclusions:

It could be concluded that the scale developed to measure the sustainability of sugarcane cultivation has utilized all the components and can be used to measure the sustainability of sugarcane cultivation. Further, it could be concluded from the results that the irrigated farmers maintained higher sustainability than the rainfed farmers in Visakhapatnam district of Andhra Pradesh.

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