
SHORT COMMUNICATION

USES OF DIFFERENT INDICES FOR RABI CROPS DIVERSIFICATION IN HARIDWAR DISTRICT

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Abstract: Haridwar District belongs to the Garhwal region of Uttarakhand known as Tarai-Bhabar region. It lies from 29 35' to 30 40' North latitude and 77 43' to 78 22' East longitude. The Major crops of the Haridwar district are Rice, wheat, sugarcane, Pulses and oil seeds but sugarcane is the main crop. The four indices: Index of Land, Sustainability Index (SI), Relative Yield Index (RYI) & Index of Crop Diversification (ICD) are used for crop diversification, sustainability & productivity. The index of land observed 36.1% minimum in year 2007-08 & in year 2000-01 maximum index of land is observed 45.5% in the area. The *Rabi* season crops data analysis where maximum sustainability index 0.79 was observed in rice crop & lowest sustainability index observed in lentils 0.42. The lowest RYI value in sugarcane crop (37) whereas highest value observed in wheat crop (154). The diversification index ranged between 0 and 1, with higher values indicating a high degree of crop diversification. The overall analysis of *Rabi* crops data observed Sugarcane, wheat & rice whereas lowest value observed in bajra, pea and gram. The present study is based on secondary sources of time series data of 20 years 2000-01 to 2019-20. The indices are used for analysis of sustainability of *Rabi* crops in Haridwar area.

Keywords: Haridwar, *Rabi* crops, Garhwal region

INTRODUCTION

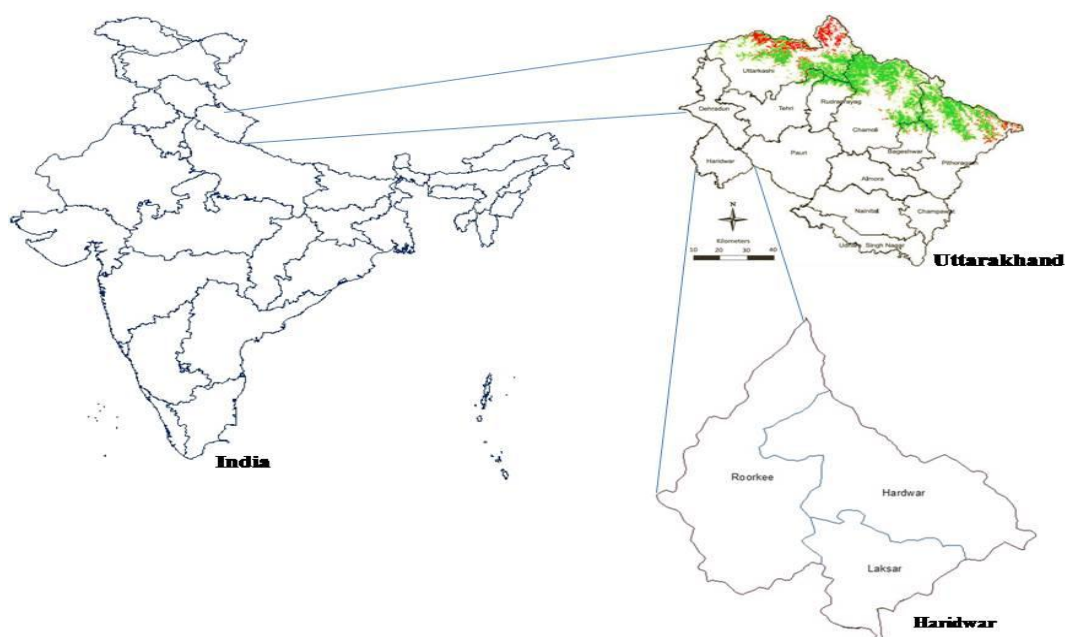
A crop is product grown for a specific purpose such as food, fiber, medicine, fuel & other purposes. The crops are need for human life. The cropping system is the series of crops grown and the management techniques used in a field over time. The cropping system refers to the crops, crop sequences and management techniques used on a particular agricultural field over a period of years. The different cropping systems are used in ancient time like Rice-wheat, Maize-wheat, Sugarcane-wheat, Rice-pulses and Rice-chickpea. The crop density found in the any region for particular season simply crop concentration means the variations in the density of crop in an area/region at a given point of time (Hussain, 1965). The *Rabi* crops are sown in mid-November, preferably after the monsoon rains are over and harvesting begins in April. The major *Rabi* crops are wheat, gram, peas, barley etc. Warm climate is needed for seed germination whereas cold climate for the growth of crops. The Vegetables crop is the most dominant cash crop in the *Rabi* season with net income (Rs. 293,125 per hectare) Mazengo *et al.* (2018). The spatial variations of the different interactions are such as

physiographic, climatic, hydrological, socio-economic and technological factors in organizational of an area. The Major crops of the Haridwar district are rice, wheat, sugarcane, pulses and oil seeds but sugarcane is the main crop.

In the present paper, Haridwar district is outlined, followed by the discussion on the different indices role under individual crops of the *Rabi* season.

Study Area: Haridwar District is belongs to the Garhwal region of Uttarakhand known as Tarai-Bhabar region. Haridwar district is situated in south – western part of Uttarakhand state of India. It lies from 29 35' to 30 40' North latitude and 77 43' to 78 22' East longitude and falls in Survey of India Degree Sheet nos. 53 J, F, G and K. Haridwar District in the Garhwal region is a district of Uttarakhand & it is divided into six development blocks. The district encompasses geographical area of 2360 sq km District Haridwar comes under hot sub-humid (dry) eco-region with alluvium-derived soils. The eco-region has hot, sub humid (dry) climate. It covers northern Indo-Gangetic Plain, including Piedmont Plain of the Western Himalayas. Agriculture is the main source of income for the people of Haridwar district of Uttarakhand (Fig.1).

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Source: State of the Environment Report-2012

Fig.1. Study area of Haridwar District

METHODOLOGY

The present study is based on secondary sources of time series data (Agriculture and Land use) of 20 years 2000-01 to 2019-20 were collected.

The data collected from websites, published records, report and bulletin of the Directorate of Agricultural Statistics and the Institute of State Planning, U.P., Directorate of Economics and Statistics, ICAR, DRR CENSUS India and other national level institute (Jain & Koshal, 2022).

Role of different indices of Rabi crops in Haridwar District:

The dominance of crop area is not providing idea of dominance of particular crop of particular area. That is based on seasonal base of area where climate is good for particular crop & area. The main concentration is rising of agricultural productivity & economic where available less fertile land. Bhatia's method (1965) is used for the calculation of the location quotient. The following formula is used to work out the concentration of crop in the Haridwar district. The method is accepted in here and categorized in three classes, viz. i) High, ii) Medium, iii) Low crop Concentration (Surendra, 2015).

The four indices are Index of Land, Sustainability Index (SI), Relative Yield Index (RYI) & Index of Crop Diversification (ICD) used for crop diversification, sustainability & productivity of rabi season crops analysis. Crop diversification is the practice of growing more than one crop in an area & adding new varieties or species of crops or by changing the current cropping system. Commonly it can mean adding more crops into an existing rotation. It can help improve food security, increase

farmer income, and promote sustainable agricultural practices. Some factors that have been found to affect crop diversification in Uttarakhand include: Fertilizer consumption, Gross irrigated area, Road length, Mechanization, and Certified. Hill region show the higher level of diversification in all the crop groups and also in the varieties, as compared to plain region. Kumar & Rai (2020) studied of the spatial variations in the degree of crop concentration area are found to be the result of the different interaction such as physiographic, climatic, hydrological, socio-economic and technological factors in organizational of Haridwar area.

i. Index of Landuse Efficiency (LUE)

It refers to increase in the output of a unit land area related to regional social and economic activities. The value nearing unity shows higher stability reflecting that the system is highly stabile.

$$\text{Index of Landuse Efficiency} = \frac{(\text{Gross cropped area})}{(\text{Net sown area})} \times 100$$

ii. Sustainability/Stability Index (SI)

Stability/Sustainability Index a good quality crop production technology should provide high yields under varying environmental conditions, i.e., keep yield fluctuations small. The statistical indicators of average dispersion, e. g. the while numerous small fluctuations are usually well tolerated by the farmer, an intense yield may be a serious risk factor. Where Stability Index, \bar{Y} is the average yield over years n , sd is the standard. Zsuzsanna Bacsí (2019).

$$\text{Stability/Sustainability Index} = \frac{(\bar{Y} - sd)}{\bar{Y}_{\max}}$$

Where, SI Stability Index, Y is the average yield over years n, sd is the standard.

The data on percent area and Productivity of major crops for different districts of Uttarakhand were collected (indiastat.com) from these 20 years (2000-01 to 2019-20) were computed by using Kanwar (1972) formula. The data related to area, production and productivity and total cultivable area of *Rabi* crops in different districts.

iii. Relative Yield Index (RYI)

RESULT AND DISCUSSION

The results and discussion related to the changes in the pattern of Crop Concentration in Haridwar district. Crop Concentration refers to the density or areal occupancy of a crop in a region. The occupancy (High, Medium and Low) is determined by the terrain and climate including temperature, humidity, transport facilities and demand of the crop. The present study is discussed under the following sub heads.

Blockwise Crop Concentration Index (CCI) of District Haridwar (1999-2000, 2004-05, 2009-2010 and 2014-2015)

RYI is low indicating non suitability of that crop. Relative Yield Index (RYI) were computed and the potential cropping districts for the study. The productivity level of crops has to be enhanced and sustained and this is possible only when efficient locations have been identified for the crops. It is the ratio of the mean yield of a particular crop in a district to the mean yield of that crop in the state and expressed in percentage.

$$\text{Relative Yield Index} = \frac{(\text{Mean yield of a crop in a district})}{(\text{Mean yield of a crop in a state/region}) \times 100}$$

iv. Index of Crop Diversification

The index of crop diversification commonly used to quantify crop diversification. Simply say the addition of new crops or cropping systems to agricultural production on a particular area or farm. The

Identification of particular crop is contributed to district level to state to national level.

$$\text{Index of Crop Diversification} = \frac{(\text{Percentage of total cropped area in 'n' crop})}{(\text{Number of 'n' crops})}$$

RESULTS AND DISCUSSION

Results of agricultural production depend on the efficiency of the use of productive resources, primarily land. Economic efficiency of land use as a means of production is determined by comparing the results of production with the area or value of land Coppock (1968) & He, S.W. (2020). The productivity of land in the hills is very low; there is a huge demand and ready market for aromatic plants. The HRDI has identified areas in selected hill regions where these crops can be grown and adopted a clustered approach that includes production and processing.

(i) Index of land of Haridwar area:

The index of land observed 2000-01 to 2019-20 data. The data were taken from Haridwar data. The overall study of area sown more than once 36.1% minimum in year 2007-08 & in year 2000-01 maximum index of land is observed 45.5%. The maximum changing scenario are seen from 2004-05 to 2001-2002 in the Table.1. In the year 2011-12 to 2014-15 lesser index of land between 37.5 to 39.3. The pattern of index of land was not more fluctuate due to not changing land pattern. The natural and manmade problems like urbanization, industrialization and deforestation are given problems. The different land use classes considered as water, riverine sand, wheat crop, forest & fallow land. The study area was selected due to diversity of land use classes, such as vegetation type, riverine sand, forest, fallow land and water. The index to land is used for trending pattern analysis of production, productivity and cost for long term data analysis of a particular area. It is also used to compare the performance of the agricultural sector to other sectors.

Table 1. Index of Land of Haridwar area

Year	Haridwar (Hectare)		
	Net Area Sown	Area Sown More Than Once (GA)	Index of Land (%)
2019-20	114062	48268	42.3
2018-19	114077	46417	40.7
2017-18	114124	45960	40.3
2016-17	114163	47951	42.0
2015-16	114059	48556	42.6
2014-15	116082	45599	39.3
2013-14	116801	46510	39.8

2012-13	117244	42742	36.5
2011-12	117913	44170	37.5
2010-11	117988	48942	41.5
2009-10	118961	52089	43.8
2008-09	118376	52488	44.3
2007-08	118282	42689	36.1
2006-07	120350	47004	39.1
2005-06	120581	47546	39.4
2004-05	120159	53468	44.5
2003-04	119998	53216	44.3
2002-03	120237	50652	42.1
2001-02	121450	50540	41.6
2000-01	120926	54980	45.5

(ii) Sustainability/Stability Index (SI)

The cropping system perform in mainly in three areas: nutritional value challenges, food loss & waste and sustainable agriculture. The social, environmental & economic aspects included as indicators for sustainable index analysis. The cash crops: sugarcane, cotton & sunflower etc are grown for improve for social status whereas environmental aspects affect the crop growth and production. The environmental factors are type of soil, climate, and direction of air, season, irrigation & light intensity. The economic aspects depend on prosperity of

farmers, update knowledge, uses of new technology & cost effective. The three aspects make any crop make to sustaining for long period for particular area. The sustainability Index need to long term pattern will see to future challenges. The crop will stable for long term sustain. The rabi season crops study were observed maximum sustainability index 0.79 was observed in rice crop & lowest sustainability index observed in lentils 0.42. The pattern of rabi crops are seen in rising pattern to rice>mustard>wheat> sugarcane (Table.2)

Table 2. Sustainability/Stability Index value of Rabi crops in Haridwar area

Sl. No.	Crop	SI value
1	Barley	0.49
2	Gram	0.59
3	Maize	0.63
4	Masoor (Lentil)	0.42
5	Peas & beans (Pulses)	0.47
6	Potato	0.55
7	Rapeseed & Mustard	0.74
8	Rice	0.79
9	Sugarcane	0.61
10	Wheat	0.64

(iii) Relative Yield Index (RYI)

It is the ratio of the mean yield of a particular crop in a district to the mean yield of that crop in the state and expressed in percentage (Table-3). Sanbagavalli *et al.* (2002). Rice Yield index are observed in *Rabi* season crops. The lowest RYI value in sugarcane

crop (37) whereas highest value observed in wheat crop (154). One such tool for identifying the potential area of crops is by calculating Relative Yield Index. The potential areas were analysis for rabi crops in the Haridwar districts Veeraputhiran. (2003).

Table 3. Relative Yield Index (RYI) value of Rabi crops in Haridwar area

Sl. No.	Crop	Average(Yield)	
		Haridwar	RYI value
1	Barley	1334	107
2	Gram	730	118
3	Maize	1723	124
4	Masoor(Lentil)	606	97
5	Peas & beans (Pulses)	808	118
6	Potato	18118	139
7	Rapeseed & Mustard	809	130
8	Rice	2102	126
9	Sugarcane	57428	37
10	Wheat	2697	154

(iv) Index of Crop Diversification (ICD)

A crop diversification index measures the extent of crop diversification in a region by considering the number of crops grown and the relative abundance of each crop. A higher index indicates greater diversification, while a lower index indicates less diversification. Indices that's have been commonly

used to quantify crop diversification. The diversification index ranged between 0 and 1, with higher values indicating a high degree of crop diversification. The overall analysis of *Rabi* crops data observed sugarcane, wheat & rice whereas lowest value observed in bajra, pea & gram (Table-4).

Table 4. Index of Crop Diversification (ICD) value of Rabi crops in Haridwar area

SL. No.	Crop	% of crop diversification
1	Barley	0.016
2	Gram	0.015
3	Maize	0.75
4	Masoor(Lentil)	0.593
5	Peas & beans (Pulses)	0.06
6	Potato	0.20
7	Rapeseed & Mustard	0.67
8	Rice	12.69
9	Sugarcane	50.41
10	Wheat	35.19

CONCLUSION**DATA AND METHODOLOGY**

Concentration of crops does not only provide an idea of a regional dominance of particular crop but also play a role of guide to strengthen agricultural economy and land use planning. It goes without saying that the judicious use of land can most definitely help in raising the agricultural production of even those areas that are less fertile. Thus, such an assessment can be useful in reducing the visible inter-regional income disparities in the agricultural sector.

Here an attempt is made to understand crop concentration the district is divided into six blocks and tried to take major crops for the study. Crop concentration is studied with the help of crop concentration index of Jasbir Singh (1976). It reveals the concentration in the six blocks of the Haridwar

district for the year of 1999-2000, 2004-05, 2009-2010 and 2014-2015.

For the clear cut picture of the study of crop concentration is made with the help of secondary data obtained from the statistical handbook of Haridwar District is analysed with the help of crop concentration index of Jasbir Singh (1976) is as shown below.

Crop concentration Index $C = \text{Pae} / \text{Par}$

Where,

C - is the crop concentration index.

Pae - is the percentage of crop 'a' to the total harvested area in the enumeration unit.

Par - is the percentage of crop 'a' to the total harvested area in the entire region of state or a country. Such techniques are useful tools in the analysis of crop patterns of any part of the region. And also it reveals that higher the crop concentration index, higher is the level of interest in the production of that crop.

The index value of a crop concentration has been categorized in three classes, viz. i) High, ii) Medium, iii) Low crop Concentration

Weather plays a vital role in the determining of existing cropping systems such as Rice-wheat, Mustard-sugarcane-ratoon-wheat & Rice-lentil cropping systems. The sugarcane is whole year crop & production is good and an important cash crop.

The out of dominant ten crops, higher crop concentration 3.97 & 0.78 were observed in sugarcane and wheat crop respectively. But lowest crop concentration 0.01 & 0.10 were observed for barley & peas crops respectively. The high value of sustainability index is high stable of the crop in the area. The rice and rapeseed & mustard crops are more stable. Crop concentration represent the density of a crop which is occupied most of the agricultural coverage in the season. The higher crop concentration 3.97 & 0.78 were observed in sugarcane and wheat crop respectively. The SI values 0.79 & 0.74 are observed for rice and rapeseed & mustard respectively. The RYI maximum values 154 & 142 for wheat and potato and minimum values 90 & 97 for peas. The Index of land-use Efficiency average overall data series of twenty years observed LUI value was 41.1 for Haridwar and average value 36.8 observed. The value of efficiency is observed in the study region.

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