Peer Reviewed International Research Journal of Geography
Maharashtra Bhugolshastra Sanshodhan Patrika
ISSN : 0971-6785 {Impact Factor 4.567 Renew (IIFS)} Vol. 39, No.1, Jan-June 2022. pp 92-96

Utility of Game Theory in Agriculture: A Case study of Washim District in West Vidarbha

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Abstract

Behavior of elements of environment is never certain and fixed. Capacity of farmers and agricultural scientist to predict and explain it certainty is very limited. Under such conditions farmers are usually defeated against environment. The decision making process about "cropmix" is dependent on experiences regarding rainfall. Choice of crops, chances of yields and market forces determine the "cropmix" of the farmers at the local and regional levls. Factors infusing the decision process differ with individual farmer in time and location. The sum total of the decision of "cropmix" is reflected in local and regional level. The choice the calculations and changes of yields in the crop combination differs at local, Regional and national levels. The perfect combination of crops and their mixing in tone and area is the prevailing problems in study region where the crops are grown under rain fed conditions, the problem of "cropmix" can be solved by using Game theory to agriculture. This theory is also useful in the suggestion of crop rotation with duration, and the theory suggested the relative share of in "minimax" solution.

In dry and wet year yield is highly variable affecting the economic conditions of the farmers. Thus attempt is made to adjust the 'cropmix' strategy to environmental condition. A model propose by Gould (1963) is use to calculate optimum counter strategy of crop on district basis. The maps are prepared for rainfall characteristics graphs and calculations are provided. Stages in the determination of optimum 'cropmix' for each tahsil by Game Theory is analyzed, "Pay of Matrix" for efficient choice for crop production is analyzed for West Vidarbha.

Introduction:

The Game Theory provides a framework for cultivators. Farmers are expected to take decision based on knowledge of his environment. He has different choices of various crops to be planted and earn his living by earning profit in subsistence farming food crops dominate the agricultural landscape the self suffiency in food is the major consideration. There is a gradual shift from food crop to cash crops self sufficiency has no meaning in modern times. The green revaluation was first initiate in this region around 1970. High yielding hybrid verities were introduced. These varieties require high doses of fertilizer and spraying insecticides. The green revolution augmentation makes farmers, "Market Oriented". The ill effects of revaluation started surfacing around 1990. The motto of high yields means high profit becomes the illusion. There was increase in prices of "inputs" required for hybrid verities. The rush and search for high profits ruined the rural economy in many regions of India and west Vidarbha is no exception. The rural economy is ruined and there is a large scale migration of rural labourers to nearby cities. In the period of 1970 to 1990 no attention is given to environmental conditions required for crops. Now farmers have realized that high yield does not mean high profits. High yielding verities show sign of failure under variable and erratic climatic conditions. Farmers realized the irrationality of choosing all sort of crops planted within the period of green revolution. The theory of Game is widely in other fields and disciplines such as economics, sociology, business, engineering and statistics.

The Game theory gives greater importance to the choice of strategy to overcome his environment. Here environment is not viewed as rival or opponent but a competitor. The farmers can choose the crops as well as strategy based on his experience and knowledge of his environment particularly rainfall characteristics.

The Game theory can predict the best choice, the strategy and proportion of land to be put to different crops on land at his disposal in a realistic and rational manner. This is the theory of utility which can be tested in the real world (Gould 1963). The Game theory can be utilized in agricultural persuits which can the rural economy on right path.

Study area:

In the present study, selected the Washim district, Washim district is important district of Maharashtra as well as Vidarbha region. It is situated of eastern part of the Maharashtra and south western part of Vidarbha region. It is lies between 90^0 61' to 21^0 16' North latitude and 76^0 7' to 77^0 14' east longitudes. Its total area covered by 5196 sq.km.

Objects of the Study:

The aim of the study is to find out the chances of application of Game theory to the existing crop combination and land use pattern of Washim district in west Vidarbha.

The rainfall characteristics of this region are most variable from year to year. The distribution of rainfall, intensity, reliability, and probability vary with locations and years. Under such conditions the associations of crop combinations and rainfall is to be tasted against Game theory.

Another object is to suggest that farmers can minimize the cost of production by restoring the principals of Game theory to maximize the profit.

Methodology:

The data used is secondary, 800 mm and 1000mm annual rainfall probability maps for Washim district is taken from the district census Handbook 2001. The crop combination region of Washim district is attempted on Tahsil basis, for which data was available (Now there are 6 tahsils). Graphs and matrices are worked out to explain the Game theory.

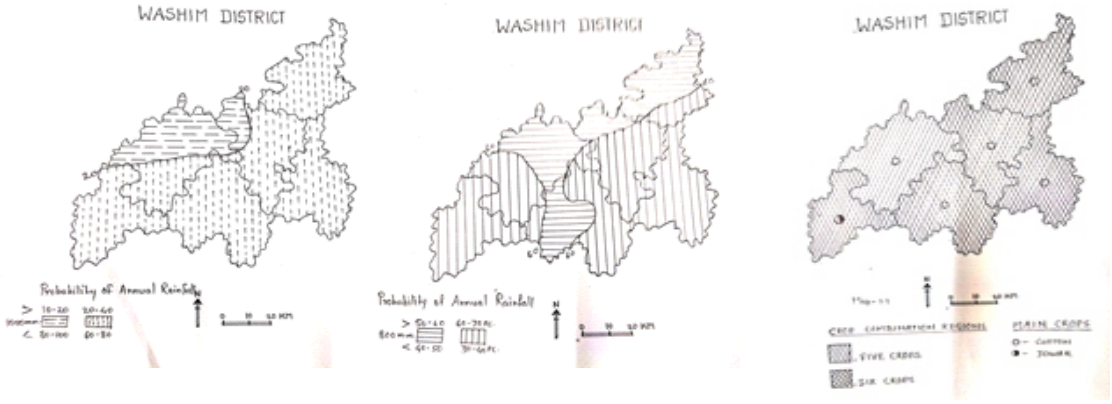
The probability of annual rainfall and crop combination:

The Game theory is related to highly sophisticated techniques of statistics and currently in use widely by agricultural scientists known as linear programming. The basic consideration of this theory is based on Stochastic models.

Table No. 1 District Washim (Year 2001-2010)

Tahsil	Average Rain fall in mm					1000mm Rain fall		800mm Rain fall	
	Jun.	Jul.	Aug.	Sept.	Average	Probability	Non occurrence	Probability	Non occurrence
Malegaon	295	190	137	155	194.00	0.19	0.81	0.24	0.76
Mangrulpir	278	235	137	138	197.00	0.20	0.80	0.27	0.73
Karanja	203	86	122	117	132.00	0.13	0.87	0.17	0.83
Manora	207	104	123	128	140.00	0.14	0.86	0.18	0.82
Washim	426	257	203	217	275.00	0.28	0.72	0.34	0.66
Risod	169	194	109	119	147.75	0.15	0.85	0.18	0.82

The study region of map (1.1 a) (1000mm and 800mm annual rainfall) reveals that large area of Washim district is covered by isoline of 20-40% probability of 1000mm annual rainfall. Small patches of less than 20% are mostly confined to region. The probability of 800mm rainfall decreases towards. North-East and increase towards South and East. It is clear that whole region receives less than 800mm rainfall.



The crop combination using Weaver's method is depicted in map no. 1.2. One tahsil out of six are having five crops in the combination. Six crop combinations predominate in major areas. High percentage of 800mm rainfall probability shows maximum of six crop combinations.
Another aspect of crop combination is that cotton and Jowar are two dominant crops. Other crops which are used in Game theory are secondary crops of some significance which partake in combination of crops. The major proportion of cultivated land is under cotton in all the central tahsils of the region.

Washim District: Short-run and Long-run Strategy of crop production:

The dry and wet years on the basic of annual rainfall and total number of rainy days was decided on the basis of 10 years data. The years which received less than 800mm annual rainfall are taken as dry years and rest are considered wet years for the period of 10 years. The production of each crop is regularly published by Bureau of Economics and Statistics, Govt. of Maharashtra. Production for dry and wet year are arranged and plotted on the graph for the study region (graph no. 1). Dominant crops associated with crop combination are selected. There are cotton, rice, tur, groundnut, wheat and Jowar. Two axis of the graph is denoted as dry and wet years and production per hectare is shown on the vertical axis. Dry year and wet year production are joined by straight line. The slope of the line indicates the difference in production of that crop in dry t years. Higher the slope greater is the difference in production. Thus there are six lines one each for a crop. The lowest point on the uppermost boundary indicates the best choice of crops. These lowest points are marked by 'S' known as saddle. The lowest point on upper most boundary for each pair of crops for Washim district is Rice and Jowar. (Graph No.-1)

Washim District - Pay off matrix for efficient choice of crop production:

The dry and wet years on the basis of total annual rainfall and total no. of rainy days was decided on the basis of 60 years data. The years which received less than 400mm annual are taken as dry years which is included in Washim, Karanja, Mangrulpir, Malegaon, Risod in June and July month and rest are considered wet years for the period of the years.

Table No. 2 Data for Pay of Matrix for efficient choice of crop production

	Rice	Wheat	Jowar	Cotton	Tur	Groundnut
Wet year	420	280	780	60	630	670
Dry year	1020	700	770	370	520	360

Pay off Matrix for efficient choice of crops and their production is worked out for the region and shown in figure No. 1. This indicates that how many years the farmers of the district should plant

each crop. The result is tabulated in the following table No.-2.
Washim District (Fig. No. – I) Pay of Matrix for Efficient choice of crop production

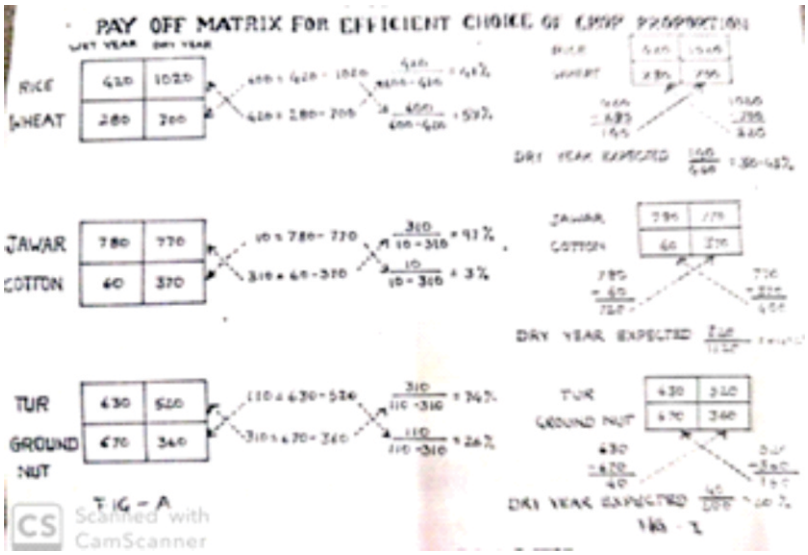


Table No. 3 Washim District- Crops

Rice	Wheat	Jowar	Cotton	Tur	Groundnut
41%	59%	97%	3%	74%	26%

The above table can be interpreted thus the farmers of Washim District can choose Jowar and Tur mixing the years in a random fashion, or they can plant their land in this proportion each year. Usually farmers are not interested in the long term strategy of 50 or 100 years. Short term strategy of 3 to 5 years can be of great help to them. If the farmer possesses 10 hectares of land he can plant 4 hectares under rice and 6 hectares under wheat. If the farmer want to follow a strategy of 5 years can be plant rice for 2 years and wheat for 3 years.

Exception of Dry years:

This is known as two by two matrix. By solving two by two matrix vertically we conclude that over the long run dry years are expected to occur in Washim district for pair crop as under.

Table – 4 Expection of dry years
Crops (in percentage)

District	Rice & Wheat	Jowar & Cotton	Tur & Groundnut
Washim	30.43%	64.28%	20.00%

If we take the period of 10 years it is most likely that dry years are expected to occur in Washim district in 3 years in a random fashion for rice and wheat combination, for cotton and Jowar 6 years within 10 years period. Thus farmers of each district can be alerted to follow short term view.

Conclusion:

The agriculture in this region is dependent on rainfall. The distribution is erractic and mark by greater percentage of variability. It is likely that efficient choice depends on crops that with stand dry spells and expectations of dry years.

The rainy season is limited to 4 months from June to September. Therefore farmers have taken advantage of crops that require less amount of rainfall. The choice naturally is for cotton and Jowar combination.

Farmers can decided randomly the occurrence of dry years and choose the crops befitting the age old experience.

High percentage of 800mm rainfall probability are the areas that shows maximum number of crops participating in crop combination.

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