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Cropping Pattern, input use and Determinants of Crop Productivity and Diversification in the State of Rajasthan

– Chander Mohan Negi*

Assistant Professor in Economics, Deptt. of Business Economics, University of Delhi South Campus

chander.mohan@south.du.ac.in https://orcid.org/000-0002-2885-0870

– Amit Pandya

MBA (BE) Student Batch 2019-21

amitpandya2021@dbe-du.org https://orcid.org/000-0003-4322-4832

ARTICLE HISTORY

Paper Nomenclature: Empirical Research Paper (ERP)

Paper Code: GJEISV13I4OD2021ERP2

Submission at Portal (www.gjeis.com): 03-Aug-2021

Manuscript Acknowledged: 06-Aug--2021

Originality Check: 06-Aug--2021

Originality Test (Plag) Ratio (Ouriginal): 08%

Author Revert with Rectified Copy: 30-Aug-2021

Peer Reviewers Comment (Open): 02-Sep-2021

Single Blind Reviewers Explanation: 15-Sep- 2021

Double Blind Reviewers Interpretation: 30-Sep-2021

Triple Blind Reviewers Annotations: 10- Oct-2021

Authour Update (w.r.t. correction, suggestion & observation): 24-Oct-2021

Camera-Ready-Copy: 08-Nov-2021

Editorial Board Excerpt & Citation: 15-Dec-2021

Published Online First: 31-Dec-2021

ABSTRACT

Purpose: Rajasthan is geographically the biggest state in India and is one of the leading producers of oil seeds in India. A significant portion is state falls under the arid and semi-arid region making the crop cultivation difficult in that portion of the state. . Agriculture Sector plays an important role in Rajasthan economy. It contribute around 30% of the state GDP and 65% of the state total population depends on agriculture and allied activities for livelihood. Thus, an effort has been made to study the most important component of the economy of Rajasthan, i.e., agriculture sector. As a considerable part of the state income and employment is being contributed by this sector in Rajasthan. Thus, changes taking place in the economy over the period of time has been studied and focus has been on the productivity and diversification of land towards high value crops.

Methodology: To gauge weather crop diversification is taking place in the state and districts of the Rajasthan Herfindhal Index have been applied. To find out the determinants of productivity and diversification of crop in the state, multiple regressions have been applied. Further, for the determinants of productivity and diversification of crops at the district level, panel regression has been used.

Findings: The overall cereal cropping area proportion has decreased from 54.87% in 1980 to 37.82% in 2014. The Cropping area for Oil Seeds has increased significantly from 8.87 % in 1980 to 20.74 % in 2014. The area under fodder crops also increased form 15 % in 1980 to 21 % in 2014.Productivity of Garlic has increased 4 times during the period of 1980 to 2014 and for onion also productivity has increased nearly around 3 times in this period.HHI for the state is shifting towards diversification of the crops. HHI has shifted from 0.17867 in 1980 to 0.16384 in 2014.Regression results for crop productivity has shown that the determinants like Fertilizer consumption, Average land holding, irrigated area and literacy rate has a positive relation with the productivity.

Originality: The paper uses the secondary data available with government sources, the state as whole has been analyzed from 1980 to 2014 for which the latest data is available. Whereas at the district level, data from 2007 to 2014 is analyzed due to unavailability of data. Changing in the cropping pattern and the area under particular crop will help the policy makers to design the policy accordingly. At the same time sophisticated tools like HHI, Multiple regression and Hausman test and panel data have been applied for this purpose.

Paper Type: Empirical Research Paper

KEYWORDS Crop Diversification | Agroclimatic Zone | Cropping Pattern | Herfindhal Index

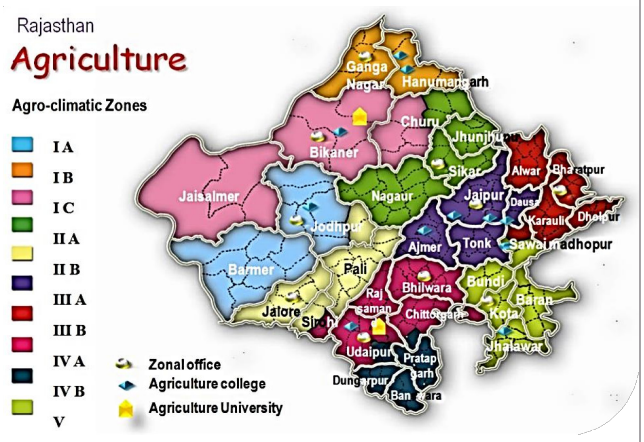
***Corresponding Author** (Chander Et. Al)*

- Present Volume & Issue (Cycle): Volume 13 | Issue-4 | Oct-Dec 2021
- International Standard Serial Number: Online ISSN: 0975-1432 | Print ISSN: 0975-153X
- DOI (Crossref, USA) https://doi.org/10.18311/gjeis/2021
- Bibliographic database: OCLC Number (WorldCat): 988732114
- Impact Factor: 3.57 (2019-2020) & 1.0 (2020-2021) [CiteFactor]
- Editor-in-Chief: Dr. Subodh Kesharwani
- Frequency: Quarterly
- Published Since: 2009
- Research database: EBSCO https://www.ebsco.com
- Review Pedagogy: Single Blind Review/ Double Blind Review/ Triple Blind Review/ Open Review

- Publishers: Scholastic Seed Inc. and KARAM Society
- Place: New Delhi, India.
- Repository (figshare): 704442/13

Introduction

Rajasthan, being the largest state of India, covers an area of 3.42 lakh sq. km which is 10.4 % area of India. It encompasses maximum of the region of the Great Indian Desert (Thar Desert). Rajasthan is placed with inside the north- western location of India. According to census, 2011, Rajasthan's population is 6.86 crore, out of which 75.11 percent consist of rural population whose primary occupation is mostly farming. Rajasthan being an arid and semi-arid region, managed the productivity of few crops more than the national average which includes Bajra, Maize, Cotton, wheat and Mustard. State of Rajasthan has its own challenges in terms of soil, as large area is under light textured soil, low water retention and poor soil health, depleting ground water and deteriorating quality of water, extreme temperatures, high-evaporation, uncertain, erratic and scanty rainfall. A large proportion of Rajasthan comes under small and fragmented holdings which directly impacts productivity. Agriculture Sector plays an important role in Rajasthan economy. It contribute around 30 % of the state GDP and 65 % of the state total population depends on agriculture and allied activities for livelihood. The State is currently divided into 33 administrative districts and has 10 agro- climatic zones. Agriculture in Rajasthan is mainly rainwater fed and occupies 13.27% of the existing land area. Groundwater sources are depleted as well as polluted. In general, one out of every three years could be a drought year. In addition to people, the state has made significant progress since independence and achieved self-sufficiency in food, grain, and grain. Today, the state of Rajasthanhas a surplus of oilseed production. The state is also rich in agro-biodiversity and has a number of unique medicinal and aromatic plants as well as legume nut and spice crops. Desert trees and shrubs, for example, khejadi, rohida, ker, ber, etc. is indigenous to Rajasthan.The state has specialized crops and cultivars that belong almost exclusively or mainly to Rajasthan. These include plants such as moths, guar, cilantro, dill, fenugreek, isabgol, mehndi and animal breeds such as Rathi, Tharparkar, Kankrej, Gir and Nagauri; Sheep Magra and Bikaneri Chokla; Marwari and Sirohi Goat et al. However, there is a desire to take advantage of the available potential of Rajasthani agriculture which remains untapped. Thus, in this context, the revival of the agricultural economy in Rajasthan is assured. Map 1 shows the 10 Agro climatic zone of Rajasthan.



Map: 1 Agro Climatic Zones of Rajasthan.

Literature Review

Fulginitiet.al. (1998 tested adjustments in agricultural productivity in 18 developing nations over the time of 1961 to 1985. The study used a non parametric,output primarily based Malmquist index and a parametric variable coefficient Cobb-Douglas production function to observe whether or not declining agricultural productiveness in much less developed nations was because of use of inputs. Econometric analysis confirmed that output growth was a result of commercial inputs like equipment and fertilizers.

The study of Brownson et. al. (2012) mounted the empirical evidence among agricultural productivity and a few key macroeconomic variables in Nigeria. The empirical effects discovered that within the short-run and long-run periods, the coefficients of actual overall exports, outside reserves, inflation fee and outside debt have considerable negative relationship with the rural productiveness. The findings name for suitable quick and long- time period monetary coverage programs that ought to stimulate funding possibilities within the agricultural region which will growth agricultural element within the country's overall export.

There have been numerous researches to find the determinants of crop diversification. A examine on character and extent of crop diversification in Karnataka state in India done by Saraswati et. al (2011) found out that crop diversification is being determined by infrastructural and technological factors. Their findings recommended that the introduction of basic infrastructural facilities such as sustained availability of irrigation water, markets, fertilizer availability, roads , and transportation, become a crucial pre-needful for creating enabling conditions for crop diversification . The research observed that crop diversification had a crucial positive impact on productivity. This examines collected secondary data from 1982 to 2008. The data was analyzed by using the Composite Entropy Index (CEI) and multiple linear regression analysis.

Another study on crop diversification carried in Pakistan by Ashfaq et. al. (2008) observed that crop diversification depends on size of landholding, the age, literacy rate, farming experience, and off-farm income of the farmer, the distance of the farm from the main market and farm machine ownership. In this research, an entropy index was used to measure diversification and, thereafter, a multiple linear regression was used to find factors affecting crop diversification.

A research by Bhattacharyya (2008) on crop diversification as a look for alternative incomes for farmers in West Bengal, India showed that agriculture sector gradually diversifying towards high value commodities like fruits, vegetables, and flowers. The study found out that maximum crop diversification came through the individual efforts of small farmers, with little aid from authorities. The major

determinant of diversification is demand-side factors that had prompted farmers to shift towards production of high value crops. In addition, transport improvement and increase in technology adoption had been key determinants for crop diversity.

A research by Ibrahim et. al. (2009) on crop and income diversification amongst farming families in a rural region of north-central Nigeria mentioned that crop and income diversification have been strategies that are essential for lowering rural poverty and raising earnings . The study used the Simpson Index of diversification and Ordinary Least Squares regression techniques for data analysis. The main determinants of cropdiversification were age of family head, education level of family head, availability of tractor hiring services, and returns on crop production.

Kankwamba et. al. (2012) carried out a research on determinants of crop diversification in Malai which used the Herfindahl Index. The agricultural zone in Malawi is quite undiversified, with maize and tobacco being the dominant staple and export crops, respectively. Despite this, the authorities had since the 2005/06 cropping season carried out the Farm Input Subsidy Program aimed commonly at growing maize productivity and output. The main determinant for crop diversification in this research was availability of technology and electrification of agricultural land.

Objectives

I. Brief study of the agricultural sector of Rajasthan in general and crop sector in specific.

II. District wise survey of crop diversification and crop productivity from 2007 to 2014.

III. State level survey of crop diversification and crop productivity of Rajasthan from 1980 to 2014.

IV. To find out the determinants of crop diversification and crop productivity.

Methodology

i. Productivity:

For Productivity, this research has used production in Kilogramper Hectare of land.

Productivity = Total production (kg) / Total area (ha)

ii. Crop Diversification: To measure the extend of diversification in crops we applied Herfindahl Index (HHI). The term 'HHI' also known as the Herfindahl–Hirschman Index, is a commonly accepted standard of crop concentration. The HHI is computed by squaring the share of each crop in the total and then summarizing the resulting numbers. The index presented below is computed by getting the total of squares of the acreage proportion of each crop in the total cropped area;

$HHI = \sum_{i=1}^{n} p_i^2$ $\quad$ p_i = proportion of i^{th} crop.

Where p_i is share of each crop defined as,

$p_i = A_i / \sum_{i=1}^{n} A_i$ $\quad$ A_i = area under i^{th} crop.

$\sum_{i=1}^{n} Ai$ = Total cropped Area.

i = 1,2, 3,……..n (no. of crops)

Here, the value of HHI ranges from 0 to 1. Where unity implies complete specialization and zero implies high diversification.

iii. Multiple Linear Regression:

To find the determinants of crop diversification and crop productivity for Rajasthan state this research has used multiple linear regression.

Regression Equation for State level:

$Y = \alpha + \beta 1*X1 + \beta 2*X2 + \beta 3*X3 + \beta 4*X4 + \ldots + \beta$

Where:

For Crop Productivity:-

Y is the dependent variable, i.e., Productivity (kg/ha)

X1, X2, X3…..are independent Variable i.e. Fertilizer Consumption per hectare, Average land holding, Irrigated Area, HHI and Literacy Rate.

For Crop Diversification:-

Y is the dependent variable, i.e., HHI

X1, X2, X3…..are independent Variable i.e. Fertilizer Consumption per hectare, Average land holding, Irrigated Area and Literacy Rate.

Panel Data Regression:

To find the determinants of crop diversification and crop productivity for district wise survey of state Rajasthan this research has used panel data regression.

iv. Hausman Test:

The Hausman test is used to test a model's misspecification. The Hausman Test detects endogenous regressors (predictor variables) in a regression model. Endogenous variables have values that are determined by other variables in the system. Having endogenous regressors in a model will cause ordinary least squares estimators to fail, as one of the assumptions of OLS is that there is no correlation between an predictor variable and the error term. In Panel data analysis, the Hausman test can assist with picking between fixed effects model or a random effects model.

Hypothesis for Hausman Test:

H0: Random Effect Model is appropriate HA: Fixed Effect Model is appropriate

Fixed Effect Model:

Fixed effects models control for, or partial out, the effects of time-invariant variables with time invariant effects.

As per the test observation, we will proceed with Fixed Effect Model.

$Y(it)=\alpha+\beta1*X1(it)+\beta2*X2(it)+\beta3*X3(it)+\beta4*X4(it)+....+\varepsilon$

Where;

For Productivity:-

Y(it) is the dependent Variable i.e. Productivity (kg/ha)

X1, X2, X3….. are our independent variable i.e. Number of electrified wells and tube wells, Literacy Rate, Fertilizers Consumption, HHI and Average land holding.

For Crop Diversification:-

Y(it) is the dependent Variable i.e. HHI

X1, X2, X3….. are our independent variable i.e. Number of electrified wells and tube wells, literacy rate, fertilizers consumption and average land holding.

Data Sources:

a. Agricultural Statistics by government of Rajasthan

b. Rajasthan Agriculture by NITI AAYOG.

c. Directorate of Economics and Statistics

d. Ground water department, government of Rajasthan.

e. Fertilizer Association of India.

- The data for the state of Rajasthan as whole have covered from 1980 to 2014, while due to paucity of data districts have been studied from 2007 to 2014.

Discussion and Results

6.1) Change in Cropping Pattern:

- Table 1 shows the percentage of crops with respect to total cropped area shows the change in cropping pattern. There is a major decline in Cereals cropping proportion from 55% in 1980 to 38% in 2014. Pulses cropping have more or less remained constant in the given period. Oil seeds cropping area has increased significantly from 9% in 1980 to 21 % in 2014. Spices and fruits and vegetables didn't show much change in cropping pattern. Also Fodder crops have increased from 15% in 1980 to 21% in 2014.

- The major shift in cropping pattern is seen in Oilseeds, Cereals and Fodder crops. Fruits and Vegetables don't account much. The area under cereals has a consistent decline while area under oilseeds, condiments and fodder crops has witnessed increase over time.

Table 1: Cropping Pattern in Rajasthan (1980-2014) (Percent).

Crop	1980	1990	2000	2010	2014
CEREALS	54.87%	50.25%	45.70%	46.85%	37.82%
PULSES	19.06%	16.94%	13.36%	16.22%	16.49%
OILSEEDS	8.87%	14.56%	19.59%	19.82%	20.74%
CONDIMENTS & SPICES	1.44%	1.68%	2.00%	2.68%	3.21%
FODDER CROPS	15.41%	16.17%	18.81%	13.70%	21.10%
FRUITS & VEGETABLES	0.35%	0.39%	0.53%	0.74%	0.63%

Source: Directorate of Economics & Statistics, Department of Planning, Rajasthan

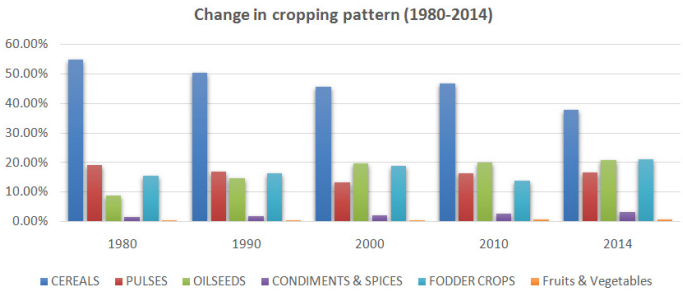


Figure 1: Changes in Cropping Pattern (1980-2014)

Source: Directorate of Economics & Statistics, Department of Planning, Rajasthan

6.2) Crop wise Area, Production and Yield in Rajasthan

- The Table 2 shows the Cropped Area (,000 ha), Production (,000 MT) and Yield(kg/ha). The major crop sown in state of Rajasthan is Bajra, this is because Bajra is well adapted to grow in hot and arid regions like Rajasthan. Other important crops sown in Rajasthan are Wheat, Maize, Gram, Rape and Mustard.

- Rice's yield per capita is increasing over the period of time because Rice is mostly cultivated in the area of Kota and Bundi which are adjoining to the Chambal River and in Hanumangarh and Ganganagar which have fertile soil as well as Canal connection.

- The Yield per hectare of Rice, Bajra, Groundnut, Wheat, Custorseed, Onion, Potato and Garlic has increased significantly. The Yield of Onion and Potato has increased from 3355 kg/ha to 11997 kg/ha and 1330 kg/ha to 12622 kg/ha respectively which is highest amongst all the crops t under study. Here, we can see the shift of cropping pattern has shifted towards high value crops. Also with advancement in technology and easily accessible of institutional loan has helped in increase in productivity.

- Amongst spices Dry chilies, Ginger, and Garlic has shown significant increase in yield in the given period. Area under cultivation of these spices also increased significantly. This also shows a shift of cropping towards high value goods.

Table 2: Area, Production and Yield of Major Crops in Rajasthan

CROPS	1980 (Area)	1980 (Pro)	1980 (Yield)	1990 (Area)	1990 (Pro)	1990 (Yield)
RICE	185.77	100.36	540.24	118.99	151.11	1269.95
JOWAR	848.41	153.33	180.73	826.90	327.60	396.18
BAJRA	4266.40	1284.73	301.16	4927.76	1829.77	371.32
MAIZE	879.62	573.69	652.21	943.63	1315.26	1393.82
SMALL MILLETS	45.24	1.51	33.31	34.35	12.10	352.34
WHEAT	2072.46	2700.88	1303.23	1650.41	3400.13	2060.17
BARLEY	423.43	488.77	1154.32	214.80	340.90	1587.09
TUR	27.18	4.91	180.52	30.94	17.35	560.68
GRAM	1377.46	749.82	544.35	1143.81	711.44	621.99
GROUNDNUT	292.16	71.42	244.46	276.21	213.99	774.73
SESAMUM	317.92	11.65	36.65	439.14	126.08	287.10
CASTORSEED	5.70	1.66	290.45	19.02	23.31	1225.31
SOYABEAN	0.00	0.00	0.00	169.00	135.19	799.96
RAPE & MUSTARD	349.04	149.04	427.00	1464.39	1277.62	872.45
LINSEED	79.70	16.74	210.00	39.60	10.98	277.25
TARAMIRA	0.00	0.00	0.00	113.68	58.11	511.18
DRY CHILIES	40.12	13.16	327.96	52.27	65.69	1256.89
GINGER	0.17	0.21	1201.15	0.03	0.14	5000.00
TURMERIC	0.17	0.24	1415.66	0.09	0.34	3706.52
CORIANDER	44.64	24.46	547.89	105.81	72.76	687.60
CUMINSEED	83.67	52.67	629.47	72.59	23.47	323.36
AJWAIN	9.56	1.17	122.82	15.52	6.40	412.57
GARLIC	4.22	7.10	1681.43	5.61	18.43	3283.68
SAUNF	1.22	0.48	391.30	3.40	2.82	827.56
METHI	36.33	35.05	964.61	30.60	30.67	1002.16
POTATO	2.41	3.20	1330.70	2.12	32.56	1538.80
ONION	10.91	36.61	3355.64	15.02	90.16	6004.40
SWEET POTATO	2.19	3.11	1420.62	1.15	4.32	3756.31

Source: Authors calculation

Table 2 Continue.....

CROPS	2000 (Area)	2000 (Pro)	2000 (Yield)	2010 (Area)	2010 (Pro)	2010 (Yield)	2014 (Area)	2014 (Pro)	2014 (Yield)
RICE	200.21	252.59	1261.66	150.69	228.28	1514.89	145.58	312.56	2147.07
JOWAR	555.95	173.22	311.58	718.57	104.35	145.23	579.62	356.79	615.56
BAJRA	3945.21	1300.76	329.70	5223.56	2053.19	393.06	4446.95	4135.03	929.85
MAIZE	933.57	968.65	1037.57	1100.21	1148.61	1043.98	926.70	1477.50	1594.38
SMALL MILLETS	14.04	0.74	53.00	17.57	1.49	84.68	12.02	2.16	179.34
WHEAT	2650.19	6731.93	2540.17	2394.21	7500.84	3132.91	3205.60	11020.14	3437.77
BARLEY	180.86	365.25	2019.50	223.44	619.86	2774.16	309.28	942.03	3045.88
TUR	25.78	15.70	608.97	18.40	7.00	380.20	14.49	9.42	650.03
GRAM	975.35	677.88	695.01	884.68	534.89	604.62	1923.50	1640.71	852.98
GROUNDNUT	274.69	265.24	965.58	336.18	371.13	1103.98	466.31	907.38	1945.87
SESAMUM	212.36	15.65	73.70	598.32	97.24	162.52	360.65	72.06	199.80
CASTORSEED	78.88	39.78	504.23	130.94	101.33	773.86	195.27	286.14	1465.36
SOYABEAN	492.41	601.05	1220.64	778.37	911.85	1171.49	1175.50	974.99	829.42
RAPE & MUSTARD	2495.05	2459.38	985.70	2212.36	2912.31	1316.38	2782.54	3620.85	1301.27
LINSEED	8.06	5.23	648.63	3.26	6.54	2004.60	2.11	2.85	1350.90
TARAMIRA	73.52	19.32	262.70	97.54	36.21	371.19	296.46	176.30	594.67
DRY CHILIES	38.00	44.55	1172.22	14.42	14.25	988.28	8.84	11.46	1296.37
GINGER	0.33	1.13	3440.37	0.17	0.47	2796.41	0.12	0.25	2000.00
TURMERIC	0.22	0.73	3267.86	0.07	0.13	1914.29	0.14	0.39	2715.28
CORIANDER	124.17	127.76	1028.89	232.27	281.24	1210.81	182.88	117.18	640.76
CUMINSEED	138.73	35.41	255.24	203.86	80.53	395.04	488.83	233.82	478.33
AJWAIN	14.41	8.15	565.73	15.49	5.46	352.09	12.62	9.22	730.35
GARLIC	18.35	56.84	3097.26	24.69	98.43	3986.27	45.02	218.22	4847.65
SAUNF	5.16	2.64	510.94	8.78	5.62	639.85	15.16	14.28	941.69
METHI	29.80	32.23	1081.69	58.82	70.19	1193.31	55.38	64.10	1157.58
POTATO	4.05	47.21	11646.93	8.53	96.39	11296.61	7.18	90.63	12622.14
ONION	25.41	170.38	6705.50	44.53	358.41	8047.90	58.22	698.50	11997.41
SWEET POTATO	1.70	4.01	2364.17	1.10	2.50	2269.51	0.64	1.98	3077.88

Source: Authors calculations from data from

6.3 Crop Diversification in Rajastahn

- Table 3 and Table 4 shows the calculation for Harfindahl Index where A is the acronym for Area (,000 ha). The Table shows that cropping pattern in Rajasthan is shifting towards diversification of crops. With advancement in technology and introduction of High Yielding Seeds has allowed farmer to shift towards high yielding crops.

Table 3: Herfindahl Index (HHI)

CROPS	1980 (A)	P=A/T	P2	1990 (A)	P=A/T	P2
RICE	185.77	0.02	0.00	118.99	0.01	0.00
JOWAR	848.41	0.07	0.00	826.90	0.06	0.00
BAJRA	4266.41	0.35	0.12	4927.77	0.37	0.14
MAIZE	879.62	0.07	0.01	943.63	0.07	0.01
SMALL MILLETS	45.24	0.00	0.00	34.35	0.00	0.00
WHEAT	2072.46	0.17	0.03	1650.41	0.13	0.02
BARLEY	423.43	0.03	0.00	214.80	0.02	0.00
TUR	27.18	0.00	0.00	30.94	0.00	0.00
GRAM	1377.46	0.11	0.01	1143.81	0.09	0.01
GROUNDNUT	292.16	0.02	0.00	276.21	0.02	0.00
SESAMUM	317.92	0.03	0.00	439.14	0.03	0.00
CASTORSEED	5.70	0.00	0.00	19.02	0.00	0.00
SOYABEAN	0.00	0.00	0.00	169.00	0.01	0.00
RAPE & MUSTARD	349.04	0.03	0.00	1464.39	0.11	0.01
LINSEED	79.70	0.01	0.00	39.60	0.00	0.00
TARAMIRA	345.35	0.03	0.00	113.68	0.01	0.00
DRY CHILIES	40.12	0.00	0.00	52.27	0.00	0.00
GINGER	0.17	0.00	0.00	0.03	0.00	0.00
TURMERIC	0.17	0.00	0.00	0.09	0.00	0.00
CORIANDER	44.64	0.00	0.00	105.81	0.01	0.00
CUMINSEED	83.67	0.01	0.00	72.59	0.01	0.00
AJWAIN	9.56	0.00	0.00	15.52	0.00	0.00
GARLIC	4.22	0.00	0.00	5.61	0.00	0.00
SAUNF	1.22	0.00	0.00	3.40	0.00	0.00
METHI	36.33	0.00	0.00	30.60	0.00	0.00
POTATO	2.41	0.00	0.00	2.12	0.00	0.00
ONION	10.91	0.00	0.00	15.02	0.00	0.00
SWEET POTATO	2.19	0.00	0.00	1.15	0.00	0.00
HHI			0.18			0.19

Source: Authors' calculations.

Table 3: Continue…

CROPS	2000 (A)	P=A/T	P2	2010 (A)	P=A/T	P2	2014 (A)	P=A/T	P2
RICE	200.21	0.01	0.00	150.69	0.01	0.00	145.58	0.01	0.00
JOWAR	555.95	0.04	0.00	718.57	0.05	0.00	579.62	0.03	0.00
BAJRA	3945.22	0.28	0.08	5223.56	0.33	0.11	4446.95	0.25	0.06
MAIZE	933.58	0.07	0.00	1100.22	0.07	0.00	926.70	0.05	0.00
SMALL MILLETS	14.04	0.00	7.00	17.57	0.00	0.00	12.02	0.00	0.00
WHEAT	2650.19	0.19	0.04	2394.21	0.15	0.02	3205.60	0.18	0.03
BARLEY	180.86	0.01	0.00	223.44	0.01	0.00	309.28	0.02	0.00
TUR	25.78	0.00	0.00	18.40	0.00	0.00	14.49	0.00	0.00
GRAM	975.35	0.07	0.00	884.68	0.06	0.00	1923.50	0.11	0.01
GROUNDNUT	274.69	0.02	0.00	336.18	0.02	0.00	466.31	0.03	0.00
SESAMUM	212.36	0.02	0.00	598.32	0.04	0.00	360.65	0.02	0.00
CASTORSEED	78.88	0.01	0.00	130.94	0.01	0.00	195.27	0.01	0.00
SOYABEAN	492.41	0.03	0.00	778.37	0.05	0.00	1175.50	0.06	0.00
RAPE & MUSTARD	2495.05	0.18	0.03	2212.36	0.14	0.02	2782.54	0.15	0.02
LINSEED	8.06	0.00	0.00	3.26	0.00	0.00	2.11	0.00	0.00
TARAMIRA	73.52	0.01	0.00	97.54	0.01	0.00	296.46	0.02	0.00
DRY CHILIES	38.00	0.00	0.00	14.42	0.00	0.00	8.84	0.00	0.00
GINGER	0.33	0.00	0.00	0.17	0.00	0.00	0.12	0.00	0.00
TURMERIC	0.22	0.00	0.00	0.07	0.00	0.00	0.14	0.00	0.00
CORIANDER	124.17	0.01	0.00	232.27	0.01	0.00	182.88	0.01	0.00
CUMINSEED	138.73	0.01	0.00	203.86	0.01	0.00	488.83	0.03	0.00
AJWAIN	14.41	0.00	0.00	15.49	0.00	0.00	12.62	0.00	0.00
GARLIC	18.35	0.00	0.00	24.69	0.00	0.00	45.02	0.00	0.00
SAUNF	5.16	0.00	0.00	8.78	0.00	0.00	15.16	0.00	0.00
METHI	29.80	0.00	0.00	58.82	0.00	0.00	55.38	0.00	0.00
POTATO	4.05	0.00	0.00	8.53	0.00	0.00	7.18	0.00	0.00
ONION	25.41	0.00	0.00	44.53	0.00	0.00	58.22	0.00	0.00
SWEET POTATO	1.70	0.00	0.00	1.10	0.00	0.00	0.64	0.00	0.00
HHI			0.16			0.16			0.14

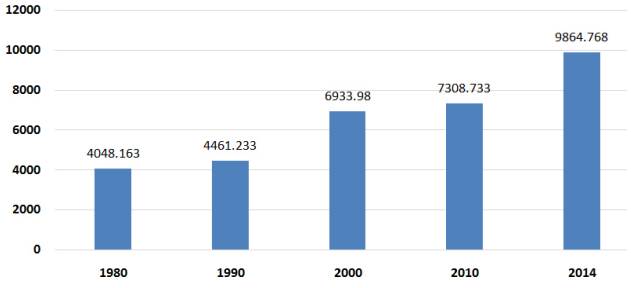
Source: Author's Calculations from dataDirectorate of Economics & Statistics, Department of Planning, Rajasthan.

From the table 3, the value of HHI increases from the 0.18 in 1980 to 0.19 in 1990, the first decades of our study shows a trend towards concentration. Thereafter, the value of HHI significantly decreases from the 0.16 in 2000 and 2010 and ultimately 0.14 in 2014. Thus, we can say that state as whole is witnessing the diversification of the crops.

6.4) Gross Irrigated Area:

Figure 2 shows the irrigated area which is increasing with a trend. With availability of modern methods of irrigating farm from the sources like Wells and Tube Wells, Subsidies in building Tanks, Canal Network are the main reasons for the increase in Gross irrigated area despite being mostly covered by desert and arid climate

Figure 2: Gross Irrigated Area

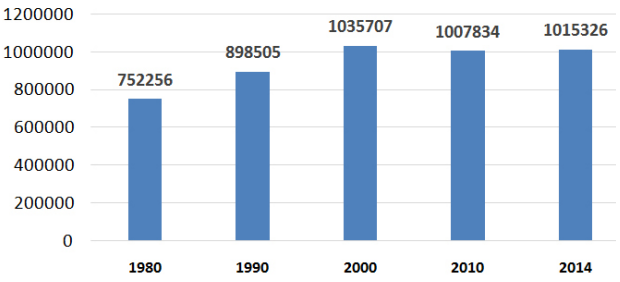


Source: Directorate of Economics & Statistics, Department of planning, Rajasthan

6.5) Number of Wells and Tube Wells:

Rajasthan has exploited ground water at a rate of 140% as per Central Ground Water Board. Figure3 shows the number of Electric wells and Tube Wells which has increased since 1980 and remained almost constant after 2000 after the introduction of ground water regulations and also many wells and Tube Wells dried due to increase in ground water depth.

Figure 3: Electrified Well and Tube Wells

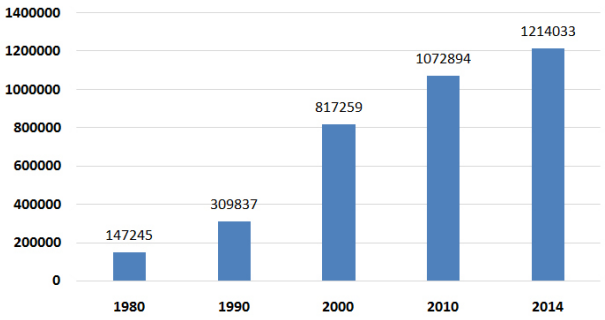


Source: Directorate of Economics & Statistics, Department of planning, Rajasthan

6.6) Fertilizer Consumption:

Figure 4shows the consumption of NPK Fertilizers (Nitrogen, Phosphorous and Potassium) in tones. There is a rapid increase in fertilizer during the period of 1980s to 2000. The reasons may be shifting from traditional farming towards commercial farming to increase output. Multiple cropping might have also contributed in increase in the fertilizer consumption in Rajasthan.

Figure 4: Fertilizer Consumption in Rajasthan



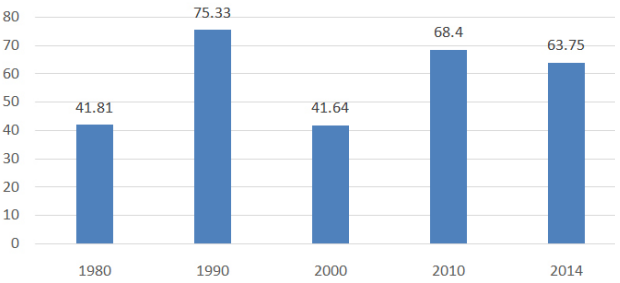
Source: Directorate of Economics & Statistics, Department of planning, Rajasthan

6.7) Rainfall:

Rajasthan is mostly under desert and a rid climate, hence receives scanty rainfall. Also the location of Araveli Mountains also diverts the rainfall, as rainy clouds from Gujrat floats parallel to Araveli.

If Araveli located in cross sectional direction then it would have helped to make clouds rain but cloads floating parallel to Araveli didn't make any difference. Figure 5 shows the average Rainfall during the period of 1980 to 2014 (cm).

Figure 5: Average Rainfall in Rajasthan

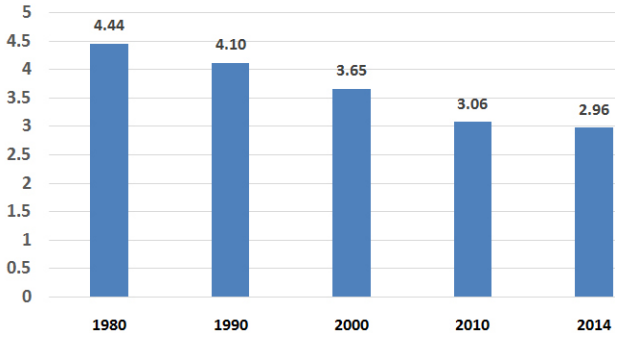


Source: Government of Rajasthan

6.8) Operational Land Holdings:

Figure 6 shows the average Land Holdings (HA) from 1980 to 2014. As we can see that average land holdings size has decreased from 1980 to 2014. The major cause of decrease in average size is population; with increase in population land is divided amongst more holders, hence decreasing in average land holding area.

Figure 6: Average Land Holding in Rajasthan (1980 to 2014)

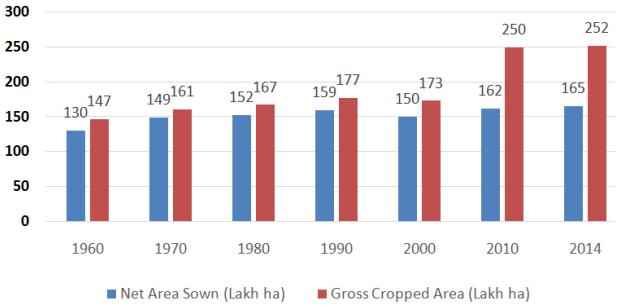


Source: Same as in figure 5

6.9) Net Cropped Area and Gross Cropped Area:

Gross Cropped Area (GCA) is the total area sown once as well as more than once in a particular year i.e. the area sown twice in a year is counted twice in GCA whereas Net Cropped Area (NCA) is the area sown with crops but is counted only once. In figure 7 we can see that the concept of multi cropping has increased during 2010 prior to that the land which was cultivated more than once is not too much as we can see that GCA and NCA are approximately equal since 1960 to 2010**.**

Figure 7: Net Area Sown and Gross Cropped Area in Rajasthan (1960 to 2014)



Source: Same as in figure 2.

District Wise Data Analysis

7.1) Crop Diversification in Rajasthan.

Table 4 shows the Harfindahl Index for all the districts of Rajasthan for year 2007, 2010 and 2014. Districts Ajmer, Alwer, Banswara and Baran. The major cropsgrowninthese districtsareJowar,Rice,Bajra,Maize,Urad,moth,Chaula, Red Chili, Wheat, Barley, Garm, Linnseed, andSunflower.

Districts with high HHI as compare to others are Nagaur, Sikar, Tonk and Udaipur. Major crops grown in these districts are Gram, Barley, Wheat, Red Chili, Guarseeds, Soyabean, Tour, Chaula and jowar. There are the two major cash crops of Rajasthan, i.e., sugarcane and cotton. Districts with fertile land and fresh water availability like Gangapur, Hanumangarh, Kota and Nagaur also have HHI above 0.006. The major crops grown in these districts are Paddy, Rice, Bajra, Urad, Tur, Groaundnut, Cotton, Sugarcane, GuarSeed, RedChili, Wheat, Barley, Matarand Masur. Hanumangarh, Kota, Bundi, Sawai Madhopur, Karauli, Chittorgarh and Udaipur and among the most fertile districts of Rajasthan. From the table 4 very little movement towards the diversification is shown by the districts.

Table 4: Herfindhal Index for Districts of Rajasthan.

Districts	HHI (2007)	HHI (2010)	HHI (2014)
Ajmer	0.0001	0.0001	0.0001
Alwar	0.0002	0.0003	0.0002
Banswara	0.0003	0.0004	0.0002
Baran	0.0004	0.0005	0.0003
Barmer	0.0033	0.0031	0.0022
Bharatpur	0.0035	0.0033	0.0023
Bhilwara	0.0035	0.0034	0.0025
Bikaner	0.0043	0.0043	0.0041
Bundi	0.0043	0.0044	0.0041
Chittorgarh	0.0044	0.0046	0.0042
Churu	0.0054	0.0057	0.0051
Dausa	0.0055	0.0057	0.0051
Dholpur	0.0055	0.0058	0.0051
Dungarpur	0.0055	0.0058	0.0052
Ganganagar	0.0059	0.0062	0.0055
Hanumangarh	0.0063	0.0066	0.0058
Jaipur	0.0067	0.0069	0.0061
Jaisalmer	0.0071	0.0072	0.0065
Jhalawar	0.0075	0.0076	0.0068
Jhalore	0.0076	0.0077	0.0070
Jhunjhunu	0.0079	0.0080	0.0072
Jodhpur	0.0093	0.0088	0.0079
Karoli	0.0093	0.0088	0.0080
Kota	0.0094	0.0089	0.0080
Nagaur	0.0104	0.0097	0.0089
Pali	0.0105	0.0098	0.0090
Rajasmand	0.0105	0.0098	0.0091
S. Madhopur	0.0107	0.0100	0.0093
Sikar	0.0110	0.0103	0.0095
Sirohi	0.0110	0.0103	0.0096
Tonk	0.0111	0.0104	0.0097
Udaipur	0.0112	0.0105	0.0097

*Source:*Government of Rajasthan, Department of Agriculture

7.2) Determinants of Crop Productivity in Rajasthan

7.2.1 Multiple Regression results for Rajasthan State (1980-2014)

Dependent Variable: Productivity (kg/ha)

Independent Variables: Ln (Fertilizer Consumption), Harfindahl Index, Average Land Holdings, and Ln (Irrigated Area).

Table 5: Regression Result of Productivity at State level.

Variable	Coefficient	P-value
Constant	1373.93	0.05
LN(Fertilizer Consumption)	18.09	0.00
Harfindahl Index	-165.31	0.07
Average Land Holding	5.07	0.60
Ln(Irrigated Area)	80.76	0.00
R^2	0.62	

Source: Author's calculations

R- Squared is .62 which shows 62.33% goodness of fit which shows the data is efficiently fit in our model. This research has taken 0.1 as level of significance. The fertilizer consumption, irrigation and trend towards diversification are coming significant determinants of crop diversification in the state of Rajasthan. One percent increase in fertilizer consumption is going to increase the productivity of land by 18 kg. Similaly one percent increase in area under irrigation is going to increase productivity per hectares by 80 kg. the coefficient of Herfindhal index is 165.31 which state that one unit decrease in HHI value or diversification will lead to 165 kg improvement in the productivity per hectares. Average land holding is having positive but insignificant impact on the productivity per hectares.

7.2.2 Determinants of Crop Productivity in Districts of Rajasthan (2007-14)

Hausman Test Results:

P-Value: 0.007

So this research moves forward with Fixed Effect.

Fixed Effect Results

Dependent Variable: Productivity (kg/ha)

Independent Variable: Ln(Electrified Wells and Tube Wells), Ln(Fertilizer Consumption), Harfindahl Index, Literacy Rate and Average Land Holdings.

Table 6: Fixed Effect Regression

Variable	Coefficient	P-value
Constant	-2542.89	0.05
Ln(Electrified Wells and Tube Wells)	218.42	0.06
Ln(fertilizer Consumption)	41.09	0.06
Harfindhal Index	-111.12	0.00
Literacy Rate	32.56	0.00
Average Land holding	0.28	0.00
R^2	.67	

Source: Author's Calculations

R-Squared is .67 which shows 67.17 percent goodness of fit which shows the data is efficiently fit in our model. Which means the model explains the 67 percent variation in the dependent variable due to the independent variables. This research has taken 0.1 as level of significance. All the variables, wells and tube wells, fertilizer consumption, diversification, literacy rate and average land holding positively and significantly affect the productivity in the districts. One percent increase in the area under the irrigation brings 218 kg increase in the productivity. Similarly one percent increase in the literacy rate spurs the productivity by 32 kg. Productivity is directly related with the land per hectares. Further, diversification of land increases the productivity by 111 kg.

7.3) Determinants of CropDiversification in Rajasthan

Multiple Regression results for Rajasthan State (1980-2014):

Dependent Variable: Harfindahl Index (HHI)

Independent Variable: Ln(Fertilizer Consumption), Average Land Holdings, and Ln(Irrigated Area).

Table 7: Regression Result

Variables	Coefficient	P-value
Constant	0.00006	0.000
LN(fertilizer Consumption)	0.0004	0.002
Average Land Holdings	0.0003	0.090
LN(irrigated Area)	0.0001	0.005
R^2	0.52	

Source: Author's Calculations

R Squared is .52 which shows 52% goodness of fit which shows the data is efficiently fit in our model. This research has taken 0.1 as level of significance. Here, fertilizer consumption, average land holding and irrigated area come as positive and significant determinants of crop diversification the state of Rajasthan.

7.4) Determinants of Crop Diversification in the districts of Rajasthan (2007-14)

Hausman Test

P-Value: 0.0011

So this research moves forward with Fixed Effect.

Fixed Effect Results:

Dependent Variable: Harfindahl Index (HHI)

Independent Variable: Literacy Rate, Ln(Electrified Wells and Tube Wells), Ln(Fertilizer Consumption) and Average Land Holdings.

Table 8: Fixed Effect Regression

Variables	Coefficient	p-value
Constant	0.00014	0.005
Literacy Rate	0.00001	0.039
Log(E_wells and Tube Wells)	0.0004	0.055
Log(fertilizer Consumption)	0.0007	0.011
Average Land Holdings	0.0003	0.077
R Squared	0.50	

Source: Author's Calculations

R-Squared is .50 which shows 50% goodness of fit which shows the data is efficiently fit in our model. This research has taken 0.1 as level of significance. The model shows that literacy rate, irrigation facilities, fertilizer consumption and average land holdings have positive and significant impact on the diversification of crops in the districts of Rajasthan.

Conclusion:

Cropping culture of Rajasthan is shifting from Cereals to Oilseeds. Among the food grains the Jowar, Bajra, and Maize has increased during the period of 1980 to 2014. The overall cereal cropping area proportion has decreased from 54.87% in 1980 to 37.82% in 2014. There has not been any significant change in cropping pattern for Pulses, Spices, Fruits and Vegetables. The Cropping area for Oil Seeds has increased significantly from 8.87 % in 1980 to 20.74 % in 2014. The area under fodder crops also increased form 15 % in 1980 to 21 % in 2014.

Productivity of Rice, Potato, Onion, Garlic and Sweet Potato has been increased significantly during the period of 1980 to 2014. Productivity of Garlic has increased 4 times during the period of 1980 to 2014 and for onion also productivity has increased nearly around 3 times in this period Cropped area for Rice and Onion has also increased but the area under Potato and sweet potato have just increased marginally.

HHI for the state is shifting towards diversification of the crops. HHI has shifted from 0.178 in 1980 to 0.163 in 2014. Districts like Ganganagar, Hanumangarh, Kota and Nagaur are shifting towards specialization of crops like Rice, Bajra, Cotton, Sugarcane and Groundnut. Districts like Ajmer, Alwar, Banswara and Baran are shifting towards diversification with major crops like Jowar, Rice, Bajra, Urad, Moth, Chaula, Red Chili, Wheat, Gram, linseed and sunflower. District like Nagaur, Sikar, Tonk and Udaipur are shifting towards cash crops like cotton, Sugarcane and fodder crop like Gaur Seed.

The state has shown the extent of multiple cropping during the year of 2005 onwards. In 2010 the Net Sown Area of Rajasthan was 162 lakh hectare and gross cropped area was 250 lakh hectares i.e. around 50 percent of cultivated land was cultivated twice in a year. Fertilizer consumption of the state also increased significantly during the same period.

Regression result for crop diversification has shown that the determinant like irrigated Area, Fertilizer Consumption, Average land Holdings, and Literacy rate has shown positive relation to Harfindahl Index.

Regression results for crop productivity has shown that the determinants like Fertilizer consumption, Average land holding, irrigated area and literacy rate has a positive relation with the productivity and HHI has negative relation towards productivity i.e. productivity increases with increasing diversification of crops.

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The Editorial Board had used the Ouriginal – a Swedish anti-plagiarism software tool which is a fully-automatic machine learning text-recognition system made for detecting, preventing and handling plagiarism and trusted by thousands of institutions across worldwide. Urkund is GDPR compliant with privacy by design and an uptime of 99.9% and have trust to be the partner in academic integrity. https://www.urkund.com] tool to check the originality and further affixed the similarity index which is {8%} in this case (See below Annexure-I). Thus, the reviewers and editors are of view to find it suitable to publish in this Volume-13, Issue-4, Oct-Dec 2021

Annexure 1

Submission Date	Submission Id	Word Count	Character Count
06-Aug-2021	D108262309 (Ouriginal)	5412	34830

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Document Information

Analyzed document	529 - Amit Kumar Pandya.pdf (D108262309)
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Reviewers Memorandum

Reviewer's Comment 1: The paper, "Cropping Pattern, Input Use and Determinants of Crop Productivity and Diversification in the State of Rajasthan" by Chander Mohan and Amit Pandya is excellent in its approach. The paper analyzes the trend in the cropping pattern and the area under the crop since 1980 in Rajasthan. They also looked at the trend in the input used in the state. It's a unique paper which analyzed the crop productivity and diversification at the state as well as district level. District level data ought to be analyzed from the 1980 or 1990.

Reviewer's Comment 2: The paper, "Cropping Pattern, Input Use and Determinants of Crop Productivity and Diversification in the State of Rajasthan" by Chander Mohan and Amit Pandey diligently inquires the state of agriculture in the state of Rajasthan. The authors apply the most advanced statistical methods in their approach. The topic itself is very interesting as the crop diversification is one of the important factors for augmenting the farmer's income. Hence their study is a time based much needed one.

Reviewer's Comment 3: The paper, Cropping Pattern, Input Use and Determinants of Crop Productivity and Diversification in the State of Rajasthan" by Chander Mohan and Amit Pandya is much needed and unique in its approach. The regional study of the important aspect of the economy like agriculture is need of the time and this study tries to fill that gap. Application of advanced instruments like panel regression enhances the strength of this paper. They study proves that at the state level there is trend towards the diversification and factors like irrigation, education and fertilizer play a dominant role in pursue towards diversification.

Citation

Chander Mohan Negi and Amit Pandya "Cropping Pattern, input use and Determinants of Crop Productivity and Diversification in the State of Rajasthan" Volume-13, Issue-4, Oct-Dec 2021. (www.gjeis.com)

https://doi.org/10.18311/gjeis/2021
Volume-13, Issue-4, Oct-Dec 2021
Online iSSN : 0975-1432, **Print iSSN** : 0975-153X
Frequency : Quarterly, Published Since : 2009

Google Citations: Since 2009
H-Index = 96
i10-Index: 964

Source: https://scholar.google.co.in/citations?user=S47TtNkAAAAJ&hl=en

Conflict of Interest: Author of a Paper had no conflict neither financially nor academically.

Editorial Excerpt

The article has 08% of plagiarism which is the accepted percentage as per the norms and standards of the journal for the publication. As per the editorial board's observations and blind reviewers' remarks the paper had some minor revisions which were communicated on a timely basis to the authors (Chander & Amit) and accordingly all the corrections had been incorporated as and when directed and required to do so. The comments related to this manuscript are noticeably related to the "**Cropping Pattern, Input Use and Determinants of Crop Productivity and Diversification in the State of Rajasthan**" both subject-wise and research-wise. The present research article aims to study the learning concerns that affected the academic progress of the children with disabilities and is based on the perspective of the parent. It makes suggestions for an appropriate learning environment for children with disabilities studying through an online mode. Overall, the paper promises to provide a strong base for the further studies in the area. After comprehensive reviews and editorial board's remarks, the manuscript has been categorized and decided to publish under "**Empirical Research Paper**" category.

Acknowledgement

The acknowledgment section is an essential part of all academic research papers. It provides appropriate recognition to all contributors for their hard work and effort taken while writing a paper. The data presented and analyzed in this paper by (Chander & Amit) were collected first handily and wherever it has been taken the proper acknowledgment and endorsement depicts. The author is highly indebted to others who had facilitated in accomplishing the research. Last but not least endorse all reviewers and editors of GJEIS in publishing in a present issue.

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