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E: ISSN NO.: 2455-0817 **Remarking An Analisation**

Construction of Average Yield Index of Principal Crops in Rajasthan

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Abstract

The study was based on secondary data on productivity of major crops in past 57 years from 1956-57 to 2013-14. The data was collected from various published sources. Principal crops of Rajasthan state considered for this study were Rice, Jowar, Bajra, Maize, Wheat, Barley, Tur, Gram, Groundnut, Seasmum, Rape and Mustard, Linseed, Cotton and Sugarcane. Factor Analysis was used to understand correlations between the variables and to find out the most prominent crops responsible for the overall variance in average yield of principal crops in Rajasthan state. With the help of factor loadings, respective weights were calculated and further Average Yield Index was developed and Trend Analysis was done and plotted. Findings revealed Mean index was at almost 75 on a scale of 100 which shows remarkable growth with consistency in Rajasthan state in due course of time. However it also directs the attention towards the improvement in this sector.

Keywords: Productivity, Principal crops, Factor Analysis, Average Yield, Factor Loadings, Average Yield Index

Introduction

About 65 per cent population of Rajasthan is dependent on agriculture and allied activities for their livelihood (Swain 2012). There exists a large variation in food grain production across states, and very high risks are involved in food grain production in the state of Rajasthan (Chand and Raju, 2009). Reducing instability in agricultural production has been a major policy concern for several years. Rajasthan is the largest state in India. It has a geographical area of 34.2 million hectares. The total cultivated area of the state is 20 million hectares. Net cropped area of the state is 18.3 million hectares, rained area 11.68 million hectares and irrigated area 6.66 million hectares in the year 2014-15. Agriculture sector in Rajasthan is prone to high risk and uncertainties which in turn make it necessary to assess the magnitude of growth as well as instability. Rajasthan's economy is primarily agricultural and pastoral. Wheat and barley are cultivated over large areas, as are pulses, sugarcane, and oilseeds. Cotton and tobacco are the state's cash crops. Rajasthan is among the largest producers of edible oils in India and the second largest producer of oilseeds. The agriculture sector is still largely based on a system of mono-cropping and is driven mainly by staples such as rice and wheat. This lack of diversification leads to greater risks of poor yields and crop failure. Given the current threat from climate change, crop diversification would act as a risk mitigation strategy for the farmers. Hence this study is done with an objectivity to construct Average yield index of principal crops in Rajasthan so as to assist policy makers and farmers as well to draw significant measures to increase average yield and also to identify the areas of improvements in near future so that transformation of agriculture in the state can be achieved.

Aim of the Study

To construct composite index to study the yield of major crops in Rajasthan.

Review of Literature

Acharya (2004), while discussing opportunities, challenges and policy formulation for agricultural development in Rajasthan made several points on the agricultural scenario of Rajasthan and suggested an agriculture policy frame work which would lead to stability and sustainability which would benefit the farmer and ultimately the state economy.Using time-series AVHRR data, Rasmussen (1992) found that the cumulative NDVI in reproductive period (maximum NDVI + 30 days until harvest) of growing season generated the highest correlation with millet yield

in Burkina Faso, Africa. Kastens et al. (2005) used biweekly AVHRR NDVI composites to predict yields for corn, soybean, and winter wheat for Iowa, North Dakota, Kansas, and Illinois. Their main effort was to develop operational image masking techniques for crop yield forecasting, model results varied depending on study regions, and specific crop types. Funk and Budde (2009) and Bolton and Friedl (2013) showed that phenological information derived from MODIS imagery can be used in conjunction with regression models to predict maize yields in Zimbabwe and for maize and soybean yields in the United States, respectively.

Methodology

The time series data of yield of principal crops viz rice, jowar, maize, wheat, barley, Tur, gram, groundnut, seasamum, rape & mustard, linseed, cotton and sugarcane were taken from 1956-57 to 2013-14. The index was constructed using factor analysis. The relative weights were computed using factor loadings. The yield of each crop was standardized with mean and standard deviation.

Results and Discussion

Factor Analysis

In order to construct Average yield index of principal crops in Rajasthan, initially Factor Analysis was done and the results are listed as below with appropriate inferences drawn on those basis.Two tests (KMO and Bartlett's)were applied to test whether the relationship among the variables is significant or not.

KMO and Bartlett's Test

Table 1: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.791
Bartlett's Test of Sphericity	Approx. Chi-Square	623.404
	Df	91
	Sig.	.000

One is Bartlett's test of Sphericity. This is used to test whether the correlation matrix is an identity matrix. i.e., all the diagonal terms in the matrix are 1 and the off diagonal terms in the matrix are zero. In short, it is used to test whether the correlation between all the variables is zero. The test value (623.404) and the significance level (P< 0.01) are given above. With the value of test statistics and the associated significance level which is so small, it appears that the correlation matrix is not an identity matrix, i.e., there exists correlations between the variables. Another test is Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. This test is based on the correlations and partial correlations of the variables. If the test value, or KMO measure is closer to one, then it is good to use the factor analysis. If KMO is closer to zero, then the factor analysis is not a good idea for the variables and data. The value of test statistic is given above as 0.791; this means that the factor analysis for the selected variables is found to be appropriate to the data.

Communalities

Table 2: Communalities

Communalities		
	Initial	**Extraction**
Rice	1.000	.562
Jowar	1.000	.787
Bajra	1.000	.861
Maize	1.000	.766
Wheat	1.000	.634
Barley	1.000	.895
Tur	1.000	.582
Gram	1.000	.579
Groundnut	1.000	.909
Seasmum	1.000	.774
Rape And Mustard	1.000	.858
Linseed	1.000	.912
Cotton	1.000	.485
Sugarcane	1.000	.689

In the above table of the communalities table, the Final Extraction values represent the proportion of each variable's variance that can be explained by the retained factors. In the common factor space, variables with high values are well represented, while variables with low values are not. This communalities table shows all variables communalities in between .485 to .912 that means there is a presence of moderate to higher degree of correlation between variable items.

Total Variance Explained

Table 3: Total Variance explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.539	53.849	53.849	7.539	53.849	53.849	4.593	32.808	32.808
2	1.615	11.535	65.384	1.615	11.535	65.384	4.124	29.458	62.265
3	1.139	8.137	73.521	1.139	8.137	73.521	1.576	11.256	73.521
4	.853	6.095	79.615						
5	.786	5.618	85.233						
6	.534	3.818	89.051						
7	.414	2.957	92.008						
8	.351	2.509	94.517						
9	.283	2.021	96.538						
10	.201	1.438	97.976						
11	.107	.763	98.738						
12	.084	.603	99.342						
13	.069	.492	99.833						
14	.023	.167	100.00						

To determine how many factors to keep, the Eigen values are used. Kaiser's criterion recommends keeping all factors with an Eigen value greater than 1 (Kaiser, 1960), which is a rule of thumb. Exploratory Factor Analysis investigates a large number of factors using a total variance explained table that includes factors, Eigen values, percentage of variance, and cumulative percentage, as well as extraction and rotation sum of square loadings. Based on the Eigen value and cumulative percentage of variance, this table assists the researcher in determining the number of factors to keep in his study. It is clear from the above table that three factors were having Eigen value above 1 and 73.521 % of cumulative variance for Seven out of 14 factors has been observed.

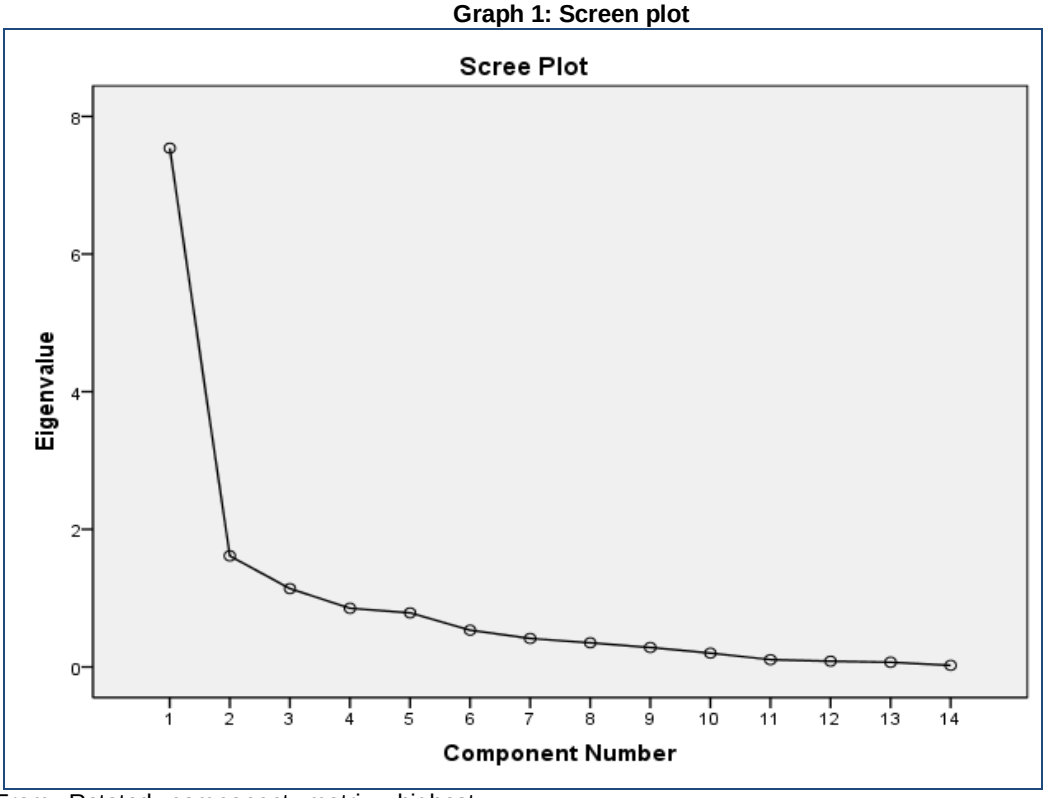
Loadings

Table 4: Loadings

	Component Matrix			Rotated Component Matrix		
	Component			Component		
	1	2	3	1	2	3
Rice	.725	-.106	.157	.397	.572	.277
Jowar	.645	-.548	.266	.049	.864	.194
Bajra	.881	-.290	-.006	.475	.791	.101
Maize	.701	-.510	-.118	.270	.823	-.125
Wheat	.280	.362	.652	.129	-.003	.786
Barley	.834	.405	-.187	.903	.217	.181
Tur	.722	-.227	-.097	.434	.627	.004
Gram	.409	.247	.592	.182	.159	.721
Groundnut	.932	.019	-.202	.765	.567	.050
Seasmum	.764	-.402	.170	.255	.820	.190
Rape And Mustard	.830	.385	-.144	.870	.235	.212
Linseed	.827	.343	-.331	.924	.240	.028
Cotton	.667	.174	.098	.535	.318	.312
Sugarcane	.771	.307	-.012	.730	.272	.288

The rotated component matrix referred to as the loadings, is the key output of principal components analysis. It contains estimates of the correlations between each of the variables and the estimated components. Same has been plotted as under.

Graph 1: Screen plot



From Rotated component matrix, highest loadings were extracted and relative weights were computed accordingly and tabulated as under.

Weights of crops in index

Table 5: Weights of crops in index

Crop	Loading	weights	weights %
Rice	0.57	0.0533	5.33
Jowar	0.86	0.0805	8.05
Bajra	0.79	0.0737	7.37
Maize	0.82	0.0767	7.67
Wheat	0.79	0.0732	7.32
Barley	0.90	0.0841	8.41
Tur	0.63	0.0584	5.84
Gram	0.72	0.0672	6.72
Groundnut	0.77	0.0713	7.13
Seasmum	0.82	0.0764	7.64
Rape And Mustard	0.87	0.0811	8.11
Linseed	0.92	0.0861	8.61
Cotton	0.54	0.0499	4.99
Sugarcane	0.73	0.0680	6.80
Total	10.73	1.00	100.00

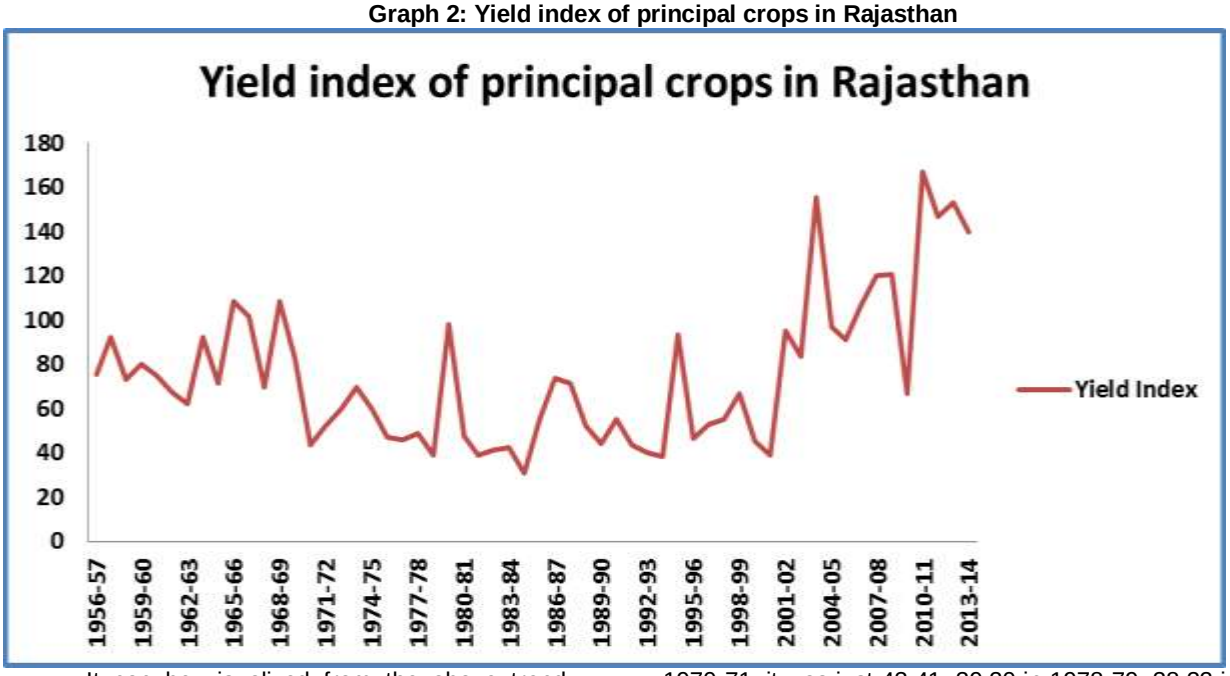
Extreme value of weights			
Highest Weight	Linseed	0.0861	8.61
Least Weight	Cotton	0.0499	4.99

It was found that highest weight among all principal crops in Rajasthan was of Linseed with 8.61% and least weight was of Cotton with 4.99%. Using these weights, Yield Index for principal crops was constructed and with the help of this index, trend of this index was established as below.

Trend of Yield Index

Trend index was plotted as under for the time duration of 1956-57 to 2013-14 for the principal crops in Rajasthan state.

Graph 2: Yield index of principal crops in Rajasthan



It can be visualized from the above trend graph very easily that a volatile trend was observed as far as average yield of principal crops is concerned. Year 2010-11 has registered highest trend index value (166.81) whereas 1984-85 was the year when this was at its lowest index value (30.95). In 1957-58, the index value was 92.32 which have risen to 139.89 in year 2013-14. Year 2003-04 has also shown a remarkable growth with index value of 155.64 as second highest trend value. In year 1970-71, it was just 43.41, 39.20 in 1978-79, 38.32 in 1993-94 and 38.92 in year 2000-01 were another years when index was found far below to the average standards otherwise average yield index has shown remarkable growth.

Descriptive statistics for Average Yield Index

On the basis of constructed index, descriptive statistics were computed. Mean, Standard Deviation, Coefficient of Variance and CAGR were computed as below

:

Table 6 : Descriptive of Yield index

Yield Index	
Mean	74.85
SD	33.264
CV	44.44%
CAGR	1.089%

Mean Yield Index was found as 74.85 which reveals more than an average performance of principal crops yield in Rajasthan State during the course of time. Coefficient of Variance was 44.44% that shows moderate consistency in terms of growth in average yield of principal crops. CAGR of almost 1.1% was achieved during year 1956-57 to year 2013-14.

Conclusion

Rajasthan's economy is primarily agricultural and pastoral. Wheat and barley are cultivated over large areas, as are pulses, sugarcane, and oilseeds. Cotton and tobacco are the state's cash crops. Rajasthan is among the largest producers of edible oils in India and the second-largest producer of oilseeds. The current study produces a detailed trend analysis of the average yield of principal crops in Rajasthan state for the time series data of more than 50 years. Descriptive statistics also reveal that the principal crops in Rajasthan state has shown consistency in their performance and has helped in achieving the target of agriculture transformation in recent years. With the help of index constructed, further research can be done in the areas of agriculture crop diversification, determinants of agriculture income and rural economic welfare and development.

References

1. *Carter, M., de Janvry, A., Sadoulet, E., & Sarris, A. (2017). Index insurance for developing country agriculture: a reassessment. Annual Review of Resource Economics, 9, 421-438.*
2. *Al-Gaadi, K. A., Hassaballa, A. A., Tola, E., Kayad, A. G., Madugundu, R., Alblewi, B., &Assiri, F. (2016). Prediction of potato crop yield using precision agriculture techniques. PloS one, 11(9), e0162219.*
3. *Zeng, L., Wardlow, B. D., Wang, R., Shan, J., Tadesse, T., Hayes, M. J., & Li, D. (2016). A hybrid approach for detecting corn and soybean phenology with time-series MODIS data. Remote Sensing of Environment, 181, 237-250.*
4. *Meng, W. A. N. G., TAO, F. L., & SHI, W. J. (2014). Corn yield forecasting in northeast china using remotely sensed spectral indices and crop*

phenology metrics. Journal of Integrative Agriculture, 13(7), 1538-1545.

5. *Sakamoto, T., Gitelson, A. A., &Arkebauer, T. J. (2014). Near real-time prediction of US corn yields based on time-series MODIS data. Remote Sensing of Environment, 147, 219-231.*
6. *Bolton, D. K., &Friedl, M. A. (2013). Forecasting crop yield using remotely sensed vegetation indices and crop phenology metrics. Agricultural and Forest Meteorology, 173, 74-84.*
7. *Mkhabela, M. S., Bullock, P., Raj, S., Wang, S., & Yang, Y. (2011). Crop yield forecasting on the Canadian Prairies using MODIS NDVI data. Agricultural and Forest Meteorology, 151(3), 385-393.*
8. *Ren, J., Chen, Z., Zhou, Q., & Tang, H. (2008). Regional yield estimation for winter wheat with MODIS-NDVI data in Shandong, China. International Journal of Applied Earth Observation and Geoinformation, 10(4), 403-413.*
9. *Kastens, J. H., Kastens, T. L., Kastens, D. L., Price, K. P., Martinko, E. A., & Lee, R. Y. (2005). Image masking for crop yield forecasting using AVHRR NDVI time series imagery. Remote Sensing of Environment, 99(3), 341-356.*
10. *Acharya, S. S. (2004). Sustainable agriculture and rural livelihoods. Natural Resources Management and Livelihood Security: Survival Strategies and Sustainable Policies, 235.*