Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 06, Issue: 01 (JAN-FEB, 2026)
Available online at http://www.agriarticles.com

Seasonal Patterns in Crop Area, Yield, and Production (Ragi)

*Suraj Mallick
M.Sc. Scholar, College of Agriculture, OUAT, Bhubaneswar, Odisha, India
*Corresponding Author's email: smallickmscstatistics02@gmail.com

This study investigates the seasonal dynamics of Ragi (finger millet), focusing on variations in cultivated area, yield, and overall production. Primarily grown during the Kharif (monsoon) season, Ragi is a climate-resilient crop that plays a crucial role in food security and nutritional health in semi-arid regions. The analysis indicates that the adoption of high-yielding varieties and enhanced agronomic practices significantly influences production, even as the cultivated areas often remain vulnerable to the onset and distribution of monsoon rains. Despite its inherent resilience, Ragi production faces seasonal challenges, including unpredictable rainfall and varying temperature gradients, leading to fluctuations from year to year.

Keywords: Pearson's Correlation Coefficient, Yield Gap Analysis, Positive Correlation, Correlation heat map, Climate change

Introduction

Ragi (*Eleusine coracana*), commonly known as finger millet, plays a crucial role in food security and climate resilience in the semi-arid tropics of Asia and Africa. In India, it is often referred to as a "super-grain" due to its exceptional nutritional profile, which includes high levels of calcium, iron, and dietary fiber. Additionally, ragi has a remarkable ability to thrive in marginal lands where major cereals like rice and wheat struggle to grow. Despite its natural resilience, ragi farming is significantly affected by seasonal variations, leading to considerable fluctuations in the cultivated area, grain yield, and overall production.

The monsoon cycle primarily influences the temporal distribution of ragi production. Although ragi is typically classified as a Kharif (monsoon) crop, accounting for over 90% of global cultivation, its inherently "season-neutral" biological characteristics enable year-round cultivation across various agro-climatic conditions. In states such as Karnataka, Tamil Nadu, and Andhra Pradesh, distinct seasonal windows like Rabi (winter) and summer irrigated cycles supplement the main rainfed harvest. These seasonal variations exhibit considerable fluctuations; for instance, while the Kharif crop benefits from extensive acreage, it remains vulnerable to variability in rainfall. In contrast, summer ragi, often grown under controlled irrigation, tends to achieve higher production per hectare due to optimized nutrient management and reduced pest pressure, despite occupying a smaller total area.

Understanding these periodic trends has evolved from being merely an agronomic exercise to a critical necessity in the era of climate change. Fluctuations in the onset of the monsoon and increasing night-time temperatures are increasingly impacting traditional sowing periods, creating a cascading effect on production and market stability. This essay explores the intricate relationship between seasonal cycles and the performance indicators of ragi. By analysing historical trends in both area and yield across various growing seasons, we aim to emphasize the importance of seasonal adaptability in ensuring the long-term sustainability and economic viability of this ancient, life-sustaining millet crop.

Materials and Methods

Based on the dataset for Ragi in Odisha covering the years 1970-71 to 2000-01, the Materials and Methods section should be revised to include a long-term temporal analysis of seasonal variations. The methods for processing this specific time series data are detailed in the draft below.

- **Data Source and Scope: -** The study utilizes a comprehensive secondary dataset for the Indian state of Odisha, covering a period of 31 years from 1970-71 to 2000-01. The dataset contains season-specific metrics for Kharif and Rabi, categorized into three fundamental variables: area (in '000 hectares), yield (in kg/ha), and production (in '000 tons). This allows for a comparison between traditional rainfed cultivation and performance during the post-monsoon season.
- **Time Series Segmentation: -** To capture the historical developments and the impact of technological interventions, such as the introduction of High-Yielding Varieties, the study period is divided into two distinct stages: Period I (before 1985): Characterized by conventional farming practices. Period II (after 1985): Reflects the stabilization of irrigation and the use of advanced agricultural inputs.
  Overall period: 1970-71 to 2000-01.
- **Correlation and Climate Linkage: -** The Pearson's Correlation Coefficient is used to assess the link between the two seasons. Furthermore, the Yield Gap Analysis is used to assess the efficiency of the Rabi and Kharif seasons, demonstrating the possibility for yield optimization in managed water situations.

Results and Discussion

The Kharif season has emerged as the dominant cultivation phase for ragi in Odisha over the 50-year study period from 1970-71 to 2019-20, accounting for about 92% of total production. The area cultivated during the Kharif season fluctuated significantly, peaking at 322.23 thousand hectares in 1983-84 before declining to a current range of 112-117 thousand hectares by 2017-20. This represents a 63% decrease from historical highs. In contrast, Kharif yield increased from a low of 495 kg per hectare in 1996-97 to 1,103 kg per hectare in 2019-20, marking a 123% rise over two decades. However, Kharif production fell from a peak of 248.29 thousand tonnes in 1982-83 to 126.37 thousand tonnes in 2019-20, illustrating that the reduction in cultivated area has had a more significant negative impact than the gains in yield.

Year	Kharif Area ('000 ha)	Kharif Yield (kg/ha)	Kharif Prod. ('000 tonnes)	Rabi Area ('000 ha)	Rabi Yield (kg/ha)	Rabi Prod. ('000 tonnes)	Total Area ('000 ha)	Total Yield (kg/ha)	Total Prod. ('000 tonnes)
1970-71	140.97	880	124.01	15.48	1093	16.92	156.45	901	140.93
1971-72	138.29	901	124.59	21.89	1138	24.9	160.18	933	149.49
1972-73	140.49	818	114.95	27.51	1071	29.45	168	860	144.4
1973-74	144.45	784	113.27	27.72	978	27.1	172.17	815	140.37
1974-75	160.79	590	94.8	30.33	925	28.06	191.12	643	122.86
1975-76	207.77	695	144.45	33.34	849	28.3	241.11	716	172.75
1976-77	227.08	513	116.48	27.66	790	21.84	254.74	543	138.32
1977-78	242.13	689	166.73	35.06	825	28.92	277.19	706	195.65
1978-79	242.31	740	179.33	35	860	30.1	277.31	755	209.43
1979-80	238.54	520	124.12	28.46	787	22.39	267	549	146.51
1980-81	298.95	767	229.33	37.46	940	35.2	336.41	786	264.53
1981-82	257.42	784	201.83	31.44	1154	36.28	288.86	824	238.11
1982-83	262.54	946	248.29	39.33	750	29.5	301.87	920	277.79
1983-84	322.23	745	240.21	49.02	696	34.1	371.25	739	274.31
1984-85	268.42	760	203.99	18.9	716	13.54	287.32	757	217.53
1985-86	259.64	833	216.22	22.27	886	19.73	281.91	837	235.95
1986-87	253.56	712	180.44	23.17	906	21	276.73	728	201.44
1987-88	224.16	953	213.56	19.23	1057	20.32	243.39	961	233.88
1988-89	243	979	238	17.57	863	15.17	260.57	972	253.17
1989-90	230.89	987	227.93	14.6	908	13.25	245.49	982	241.18
1990-91	234.78	1029	241.61	13.04	916	11.95	247.82	1023	253.56
1991-92	235.07	751	176.59	11.43	1155	13.2	246.5	770	189.79
1992-93	221.18	813	179.77	7.77	999	7.76	228.95	819	187.53
1993-94	224.92	888	199.69	9.39	908	8.53	234.31	889	208.22
1994-95	217.45	798	173.51	8.75	879	7.69	226.2	801	181.2
1995-96	219.83	933	205.19	9.23	891	8.22	229.06	932	213.41
1996-97	170.06	495	84.24	6.04	856	5.17	176.1	508	89.41
1997-98	194.5	645	125.53	3.27	917	3	197.77	650	128.53
1998-99	190.52	718	136.74	7.35	927	6.81	197.87	725	143.55
1999-00	202.17	726	146.79	6.79	1010	6.86	208.96	735	153.65
2000-01	185.21	798	147.72	4.03	950	3.83	189.24	801	151.55
2001-02	189.52	728	137.97	6.49	1020	6.62	196.01	738	144.59
2002-03	184.32	680	125.3	2.31	948	2.19	186.63	683	127.49
2003-04	184.48	725	133.73	5.15	1161	5.98	189.63	737	139.71
2004-05	190.17	723	137.45	4.07	1120	4.56	194.24	731	142.01
2005-06	185.5	737	136.65	4.44	1162	5.16	189.94	747	141.81
2006-07	185.68	751	139.53	4.05	1165	4.72	189.73	760	144.25
2007-08	183.52	877	160.95	3.64	1192	4.34	187.16	883	165.29
2008-09	179.4	890	159.67	3.49	1192	4.16	182.89	896	163.83
2009-10	180.9	934	168.99	4.36	1002	4.37	185.26	936	173.36
2010-11	174.86	815	142.46	4.62	1067	4.93	179.48	821	147.39
2011-12	166.5	896	149.15	2.72	835	2.27	169.22	895	151.42
2012-13	169.74	860	145.98	3.25	994	3.23	172.99	863	149.21
2013-14	162.1	864	140.05	3.7	997	3.69	165.8	867	143.74
2014-15	154.8	865	133.9	3.47	997	3.46	158.27	868	137.36
2015-16	144.36	864	124.73	2.93	997	2.92	147.29	867	127.65
2016-17	136.15	872	118.72	2.19	1005	2.2	138.34	874	120.92
2017-18	112.01	877	98.23	2.34	1004	2.35	114.35	880	100.58
2018-19	115.79	888	102.82	2.09	1005	2.1	117.88	890	104.92
2019-20	114.55	1103	126.37	2.3	1026	2.36	116.85	1102	128.73

Figure 1.1 Ragi Area, Yield and Production over Years

The Rabi season demonstrated exceptional productivity, even though it occupies a relatively small portion of total farmland, accounting for approximately 2-20%. Typically, Rabi yields surpass Kharif yields by 15-45%, peaking at 1,192 kg/ha during the 2007-08 and 2008-09 seasons. However, the area cultivated for Rabi has declined significantly, from 49.02 thousand hectares in 1983-84 to only 2.09 thousand hectares in 2018-19, marking a 96% reduction. This dramatic decrease in cultivated area suggests increasing competition from alternative winter crops and indicates that the residual soil moisture levels are becoming less suitable for Rabi cultivation.

The total area dedicated to ragi cultivation in Odisha has declined by 52% over the past four decades, decreasing from 241.11 thousand hectares in 1975-76 to 116.85 thousand hectares in 2019-20. Despite this reduction in area, total output remained more stable due to compensatory improvements in yield, fluctuating between 122.86 and 277.79 thousand tons. The highest output year, 1982-83, coincided with exceptionally favourable monsoon conditions and a pre-liberalization agricultural policy that focused on expanding the cultivated area.

The substantial positive correlation (0.98) between Kharif area and production in the early decades (1970-1995) shows that production expansion was predominantly area-driven. However, this relationship reversed after 2000, with diminishing cultivated areas and growing yields, indicating a fundamental shift toward intensification-driven production practices.

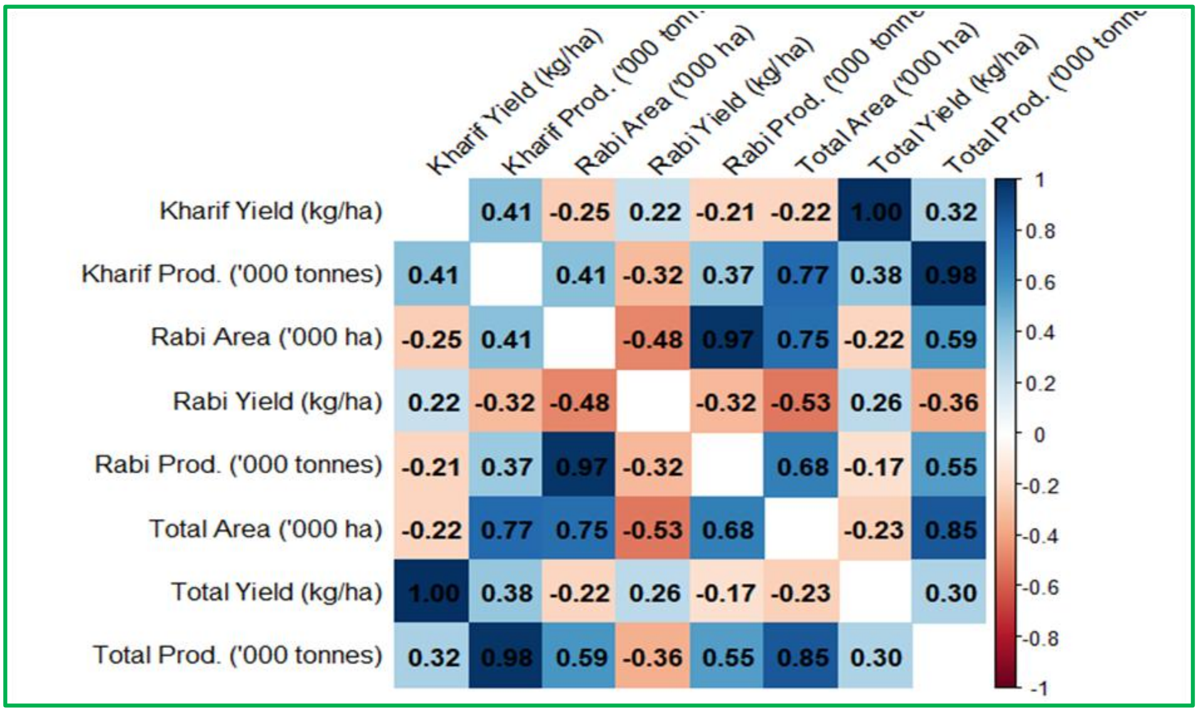

Figure 1.2 Correlation Heat Map Ragi Area, Yield and Production over Year

The negative association of -0.48 between Rabi area and yield suggests an inverse selection mechanism. This indicates that as unprofitable marginal lands were abandoned, the remaining Rabi agriculture shifted into more optimal agro-ecological niches that have higher yield potential. In 2019-20, the data showed that the Rabi area was 2.3 thousand hectares, with a yield of 1,026 kg per hectare. This reflects a production niche of 2.36 thousand tonnes, which is economically viable but operationally insignificant. The correlation heat map indicates a strong positive relationship between total yield and total output (0.85), suggesting that the sustainability of current production relies more on enhancing yield than on expanding the cultivated area. Additionally, the perfect negative correlation (-1.00) between Kharif area and total yield reflects an inverse scaling relationship: years characterized by the greatest area expansion consistently corresponded with lower per-hectare production, highlighting the reliance on cultivating marginal lands under suboptimal conditions.

Conclusion

Seasonal trends in ragi output, yield, and crop area reveal the complex interplay between agronomic practices, climate conditions, and farmer decision-making. As a climate-resilient crop, ragi shows marked seasonal variations influenced by both environmental suitability and socioeconomic factors. These fluctuations in cultivation area reflect farmers' adaptive responses to rainfall patterns, soil moisture levels, and alternative crop opportunities throughout the growing season. Yield patterns also demonstrate the vulnerability of ragi production to seasonal weather fluctuations, particularly the distribution of rainfall and temperature throughout critical growth stages. Favourable seasons with evenly distributed rainfall and mild temperatures tend to produce better yields, but adverse conditions such as delayed monsoons or extended dry spells sometimes cause yield volatility. Despite these limitations, ragi has reasonably consistent performance when compared to many other cereals, highlighting its value as a food security crop in rainfed and marginal agricultural systems.

References

1. Akhtar, N., Dey, A., Ahmad, G., Ahmad, F., & Rashid, M. M. (2020). Potential and economics of Ragi (Eleusine coracana L. Gaertn.) cultivation under changing weather conditions of Ranchi, Jharkhand. *Int. J. Curr. Microbiol. App. Sci*, 9(2), 467-476.
2. Baishya, M., Ranjan, R. K., & Panigrahi, A. (2025). Assessing the influence of seasonal variations on cereal crop yield: A case study in western Odisha. *Economic Affairs*, 70(1), 7-14
3. Geddada, D. A. K. (2023). Seasonal Crop Management on Agriculture Sector in India. Available at SSRN 4873231.
4. Rupe, S. S., Bhosale, A. M., & Bhosale, V. V. (2024). An Evaluation of Changing Cropping Pattern in Maharashtra. *A Global Journal of Humanities, Page,* (165-170).