Rainfall and Rice Productivity Analysis Report

Correlation and Scenario Evaluation Study (1966–2017)

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1. Introduction

This study examines the relationship between monsoon rainfall and rice cultivation area across selected Indian states between 1966 and 2017. The objective is to determine whether rainfall significantly influences agricultural land allocation and to evaluate rainfall variability through scenario modeling.

The analysis was conducted using Power BI for visualization and DAX-based statistical modeling, supported by correlation analysis using Excel.

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2. Data Preparation and Processing

The dataset included:

- Monthly rainfall (June–September)
- Rice cultivation area (in 1000 hectares)
- State-level observations

Data cleaning steps included:

- Removing missing/null values
- Ensuring numeric data types
- Standardizing state names
- Removing unused columns
- Added custom column to categorize rainfall density

```
Rainfall Density =
    SWITCH(
        TRUE(),
        [Total Rainfall] < 500, "Low",
        [Total Rainfall] < 1000, "Medium",
        "High"
    )
```

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3. DAX measure creation:

a. Total Rainfall = SUM('rain-agriculture'[AUG])+SUM('rain-agriculture'[JUL])+SUM('rain-agriculture'[JUN])+SUM('rain-agriculture'[SEP])

b. Average Rainfall = AVERAGEX('rain-agriculture', 'rain-agriculture'[JUN]+'rain-agriculture'[JUL]+'rain-agriculture'[AUG]+'rain-agriculture'[SEP])
c. Total Rice Area = SUM('rain-agriculture'[RICE AREA (1000 ha)])
d. Average Rice Area = AVERAGE('rain-agriculture'[RICE AREA (1000 ha)])

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4. Parameters created: Rain fall Adjustments

1. **Created DAX Measures**
    a. Adjusted Total Rainfall =
    [Total Rainfall] *
    (1 + 'Rain fall Adjustments'[Rain fall Adjustments Value] / 100)
    b. Adjusted Rice Area =
    [Total Rice Area] *
    (1 + 'Rain fall Adjustments'[Rain fall Adjustments Value] / 100)

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5. Correlation Analysis

5.1 Method Used

The Pearson correlation coefficient was calculated using the DAX formula:

```
Total Rainfall and Total Rice Area correlation for State Name =
VAR __CORRELATION_TABLE = VALUES('rain-agriculture'[State Name])
VAR __COUNT =
    COUNTX(
        KEEPFILTERS(__CORRELATION_TABLE),
        CALCULATE([Total Rainfall] * [Total Rice Area])
    )
VAR __SUM_X = SUMX(KEEPFILTERS(__CORRELATION_TABLE), CALCULATE([Total Rainfall]))
VAR __SUM_Y = SUMX(KEEPFILTERS(__CORRELATION_TABLE), CALCULATE([Total Rice Area]))
VAR __SUM_XY =
    SUMX(
        KEEPFILTERS(__CORRELATION_TABLE),
        CALCULATE([Total Rainfall] * [Total Rice Area] * 1.)
    )
VAR __SUM_X2 =
    SUMX(
        KEEPFILTERS(__CORRELATION_TABLE),
        CALCULATE([Total Rainfall] ^ 2)
    )
VAR __SUM_Y2 =
```

```
    SUMX(
        KEEPFILTERS(__CORRELATION_TABLE),
        CALCULATE([Total Rice Area] ^ 2)
    )
RETURN
    DIVIDE(
        __COUNT * __SUM_XY - __SUM_X * __SUM_Y * 1.,
        SQRT(
            (__COUNT * __SUM_X2 - __SUM_X ^ 2)
                * (__COUNT * __SUM_Y2 - __SUM_Y ^ 2)
        )
    )
```

5.2 Results

- **Correlation (r) = –0.21**
- **R^2 = 0.044 (4.4%)**

5.3 Interpretation

The correlation coefficient of –0.21 indicates a **weak negative relationship** between rainfall and rice cultivation area across states.

This means:

- Higher rainfall does not correspond to increased rice cultivation area.
- In fact, there is a slight inverse relationship.
- Rainfall explains only **4.4% of the variation** in rice area.

Therefore, rainfall alone is not a strong determinant of rice land allocation.

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6. Cross-State Productivity Insights

Analysis of state-level data reveals:

- West Bengal (~10.6K) and Orissa (~8.4K) are leading rice-producing states.
- High-rainfall states such as Kerala (~0.9K) and Himachal Pradesh (~0.4K) show significantly lower rice cultivation area.
- The top three states account for nearly 29% of total rice area.

This supports the statistical finding that rainfall volume does not directly determine cultivation scale.

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7. Rainfall Trend Analysis

Time-series analysis of rainfall (1966–2017) indicates:

- Significant variability across decades.
- A structural upward shift around the early 1990s.
- Post-1990 rainfall stabilizing between approximately 14K–20K units annually.

However, this structural increase did not correspond to proportional increases in rice cultivation area.

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8. Scenario Modeling

A What-If parameter (–30% to +30%) was implemented to simulate rainfall variability.

Initially, rice area was modeled proportionally to rainfall changes. However, given the weak negative correlation (–0.21), the model was revised to reflect empirical evidence.

Revised scenario logic:

Adjusted Rice Area = Rice Area*(1 + (Rainfall Adjustment % * -0.21))

This adjustment ensures that scenario simulations reflect observed statistical relationships rather than unrealistic proportional assumptions.

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9. Key Findings

1. There is a **weak negative correlation (–0.21)** between rainfall and rice cultivation area.
2. Rainfall explains only **4.4% of variation** in rice area.
3. High rainfall does not guarantee high rice cultivation.
4. Productivity is strongly influenced by structural factors such as irrigation infrastructure, soil suitability, cropping patterns, and regional agricultural policy.
5. Scenario modeling confirms limited sensitivity of rice area to rainfall changes.

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10. Limitations

- Correlation does not imply causation.
- Analysis is cross-sectional across states; time-lag effects were not modeled.
- Rice area was used as a proxy for productivity; yield per hectare may provide deeper insight.
- External factors such as irrigation coverage were not included in the dataset.

11. Conclusion

The study demonstrates that rainfall has only a weak and slightly negative statistical association with rice cultivation area across states. With rainfall explaining just 4.4% of variability, agricultural productivity appears to be primarily driven by structural, technological, and geographic factors rather than rainfall volume alone.

While rainfall remains a necessary input in agriculture, this analysis suggests that long-term productivity planning should focus more on irrigation development, crop management practices, and regional agricultural infrastructure rather than relying solely on rainfall variability.