FORECASTING OF MONSOON RAIN IN THE YEAR 2025 IN JHARKHAND

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Abstract— **Jharkhand frequently faces drought like situation quite often. Therefore, it requires careful planning before planting of crops. The planting of crops involves sufficient capital for the poor farmers who borrow money either from the banks or from private money lenders at much higher rates. Since the amount is heavy for the farmers, the crop failure can lead to farmer's suicide. Therefore, information about the future rain is very important. The earlier the information is available the better it will be for planning. This research is being carried out with this point in mind.**

In this research the data is collected over 32 years and based on these - three methods are used for prediction. The predicted value is the average of the three method results.

The methods are: (1) the Fast Fourier Transform (FFT) method, (2) the Time Series method, and (3) the Root Mean Square (RMS) method using linear regression analysis,and the Artificial Neural Network (ANN) method.

***Index Terms*— Monsoon rain prediction, annual rainfall, rainfall frequency spectrum, El Nino and La Nina influence on rainfall, drought and famine, crop failure**

1. INTRODUCTION AND OBJECTIVE OF RESEARCH

Figure 1 shows the map of Jharkhand. It is a rocky area and storing water is difficult. Being rocky, drilling is difficult. This place suffers from lack of rain quite often. Many efforts have been made in the past for making arrangements for irrigation. Digging canals is difficult and costly. So is making reservoirs for storing water. Due to these factors and deficient rain - quite often the crop failures happen [1-6].

The crop failure results in decreased purchasing power for the farmers who are really dependent on monsoon rains. In India, about 68% of the agriculture land is dependent on monsoon rain for irrigation. The lack of rain causes slowing down of the economy of India [7].

It becomes problematic when a country's water reserve becomes below 1,000 cubic meters per person per year; the country then faces water shortage [8]. About 700 million people in 43 countries were living below the 1,700 cubic meters per person threshold. Water stress has increased in regions such as China, India, and Sub-Saharan Africa, which has the largest population of the world.

The global warming effects are being felt throughout the world. For example, the state of California in United States of America (USA) went through a six-year drought period. As a result of this, the hydroelectric power stations had to be stopped many times.

The lack of rain not only affects agriculture, but It also affects city supply, and hydropower as been discussed in [9]. The deficient rain conditions change the lifestyle of various places. One problem with Jharkhand is that it doesn't have sufficient number of reservoirs for storage of water.

These days one finds the level of reservoirs to be low and affecting agriculture as well as generation of hydropower [10,11]. Not only Jharkhand but also many other areas of India are suffering from water shortages [12-31].

Many researchers have found this problem to be quite troublesome and their research work can be seen in [32-39]. In this respect rainfall data by Indian Meteorological Department (IMD) can be seen in [40].

The present study has been undertaken to help farmers plan for the crop planting and purchasing of seeds etc. The help comes from forecasting well in advance about 7 months - about the rainfall in the next monsoon. This would also help planning for the hydropower generation as well as the municipalities who have to supply water to the cities.

2. RESULTS AND DISCUSSIONS

Fig. 2 shows the results of calculations using the Time Series method, the Fast Fourier Transform method (FFT), the Root Mean Square (RMS) method, the Artificial Neural Network (ANN) and the actual rainfall record for the month of June. The details about these methods can be seen in [41-43]. In this figure one can see that the actual rainfall varies quite rapidly from year to year whereas the calculated values for the other methods do not show that kind of variation.

In the Table 1 one can see the summary of results. Here, one can see that the FFT method gives the highest value and the RMS method - the lowest. The predicted value is the average of these three methods. One can compare the predicted value with the average of past 32 years. It shows that the predicted value is less than the 32-year average value.

Fig 2 shows various outputputs computed by different methods. It shows that the actual rain values differ each year very rapidly.

In Fig. 3, the Time Series method and the RMS method both show a similar declining trend. The actual rainfall curve shows rapid changes from year to year. The FFT method results also vary but not to the same extent as the actual rainfall amounts.

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In Fig. 4, the difference between calculated methods is less than the previous figure. The actual rainfall values show variations similar to the ones in the previous figures.

In Fig. 5, the RMS method shows a declining trend whereas the Time Series method shows an increasing trend. The FFT method results fluctuate just like the actual rainfall values. The variation in the actual rainfall is larger as compared to the FFT method.

The total value of rain is shown in Fig. 6. In this figure, the Time Series method shows increasing trend. The difference between all the results is much smaller in this figure. The actual rainfall varies from year to year is just like before.

Fig. 7 shows the amplitude versus frequency number. In this figure the frequency numbers 1, 3, 5, 6, 8, 9 and 10 have amplitudes greater than 4 centimeters. All other frequency numbers exhibit their amplitudes less than 4. This shows that there are sufficient number of frequencies whose amplitudes are significant.

3. CONCLUSIONS

In this work, the calculations of the rainfall were carried out using the Time Series method, the FFT method, and the RMS method, and the ANN method. The Time Series method, and the RMS method show a uniform variation in all calculations. The FFT method results show fluctuations but not as much as those in the case of the actual rainfall. The ANN method results were the lowest in all the figures.

Based on this study one can conclude the following:

1. There is sharp variations in the actual rainfall values from year-to-year.

2. The Time Series method and the RMS method results show linear variation due to linear regression. However, the slopes of these curves did show opposite variation in many of the curves.

3. The FFT method results are sum of various harmonics, and they fluctuate fair bit from year to year. The total variation in this method is less than that of the actual rain values.

4. This year - overall there will be less rain amount than the 32-year average as shown in Table 1.

5. The ANN method yields the least result.

4. REFERENCES

1. Jharkhand inches towards drought-like situation due to scant rainfall, 2023

2. Farmers in Jharkhand are distraught due to deficit in rainfall in monsoon, 2023

3. Govt Serious About Addressing Farmers' Problems In Rain Deficit Jharkhand: CM, 2023

4. **Far**mers stare at drought as Jharkhand rain deficit crosses 50%,2019, https://reliefweb.int/report/india/farmers-stare-drought-jharkhand-rain-deficit-crosses-50

5. Jharkhand witnesses 35% rainfall deficit, 2019, https://www.indiatoday.in/india/story/jharkhand-rainfall-deficit-1564404-2019-07-08

6. Water Shortages in India. 2019, https://earthobservatory.nasa.gov/images/145242/water-shortages-in-india

7. What lack of rainfall could mean... ? http://www.ndtv.com/india-news/what-lack-of-rainfall-could-mean-396622

8. Water scarcity,https://en.wikipedia.org/wiki/Water_scarcity

9. With the Rain Comes Hope That 6-Year California Drought Is Ending, https://www.nytimes.com/2017/01/13/us/california-drought-weather-rain-snow-floods.html?_r=0.

10. Sinha, S. P., 2011, " Use of Remote Sensing and Geographical Information System (GIS) Technology ….. ", Ph. D. Thesis, Ranchi University, Ranchi, India, CH 1-5

11. Sharan, Anand M., 2015, "Prediction of Rain in Bihar, India, Based on

12. Historical Rain Data ", Asian Journal of Water, Environment and Pollution, Vol. 12, No. 3 pp. 59–64.

13. Sharan, Anand M., 2015, On the Rainfall in Marathawada and the Need for the Farmers to Have an Alternate Source of Income, http://www.engr.mun.ca/~asharan/RAINMARATHAWADA/RAIN_MARATHAWADA_V2.pdf.

14. Telangana's Shocking Statistics: 350 Farmer Suicides in Five Months, http://www.ndtv.com/article/south/telangana-s-shocking-statistics-350-farmer-suicides-in-five-months-616371

15. How Telangana Farmer's Suicide Has Changed the World of His Daughter. http://www.ndtv.com/article/south/how-telangana-farmer-s-suicide-has-changed-the-world-of-his-daughter-572462

16. Farmer's Suicide in Vidarbha : Everybody's Concern , http://medind.nic.in/jaw/t09/i2/jawt09i2piii.pdf

17. 10. Farmers' Suicides in the Vidarbha Region of Maharashtra, India a Qualitative Exploration of Their Causes, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3291283/

18. Four more Maharashtra farmers commit suicide, http://www.thehindu.com/news/national/four-more-maharashtra-farmers-commit-suicide/article6655587.ec

19. Three Farmers Commit Suicide in Draught-Hit Marathwada Region, http://zeenews.india.com/news/maharashtra/three-farmers-commit-suicide-in-draught-hit-marathwada-region_1508366.html

20. India is already facing a water crisis—and it is only going to get worse, https://thediplomat.com/2014/04/indias-worsening-water-crisis/

21. In Gujarat's water crisis, key question: why is Narmada's level low this year?, http://indianexpress.com/article/explained/in-gujarats-water-crisis-key-question-why-is-narmadas-level-low-this-year-5113688/

22. Water shortage in Gujarat's Morbi forces people to dig holes in the ground, http://indianexpress.com/photos/india-news/gujarat-morbi-water-crisis-narmada-river-5119373/

23. Gujarat staring at water crisis this summer, http://indianexpress.com/article/india/gujarat-staring-at-water-crisis-this-summer-5042137/

24. Water scarcity threat to India and South Africa - Climate News Networhttps://climatenewsnetwork.net/23742-2/

25. India's escalating water crisis -, https://www.livemint.com › Politics › Policy

26.India's potable water crisis is set to worsen , https://www.livemint.com › Politics › Policy

27.India's fast-growing cities face water crisis - Phys.org, https://phys.org › Earth › Environment

28.India drought: '330 million people affected', http://www.bbc.com/news/world-asia-india-36089377

29.Drought years may become more frequent in India, says study, http://indianexpress.com/article/india/india-news-india/maharashtra-gujarat-drought-waterless-monsoon-crisis-years-may-become-more-frequent-in-india-says-study-2826500/

30.The Thirst for Power: Hydroelectricity in a Water Crisis World, http://www.brinknews.com/the-thirst-for-power-hydroelectricity-in-a-water-crisis-world/

31.Sharma, R. K., & Sharma, S. (2014). Design of HPCF with nearly zero flattened Chromatic Dispersion. International Journal of Engineering and Applied Sciences, 1(2).

32.Gadgil, S and Srinivasan, J (2012). Monsoon Prediction: Are Dynamical Models Getting Better Than Statistical Models?", J Current Science VOL. 103, NO. 3, 10 August

33.Delsole, T. and Shukla, J. (2012). Climate Models Produce Skillful Predictions of Indian Summer Monsoon Rainfall. Geophys. Res. Lett Volume 39, Issue 9, May

34.Prediction of Rain in Bihar, India Based on Historical Bihar's Rain Data. http://www.engr.mun.ca/~asharan/RAINBIHAR/RAIN_BIHAR_V12.pd

35.Singh, K., Panda, J., Kant, S.,2020, A Study on Variability in Rainfall over India Contributed by Cyclonic Disturbances in Warming Climate Scenario, International Journal of Climatology, 40 (6), pp. 3208-3221.

36.Mathur, R., AchutaRao, K., 2020, A Modelling Exploration of the Sensitivity of the India's Climate to Irrigation, Climate Dynamics, 54 (3-4), pp. 1851-1872

37.Prathipati, V.K., Naidu, C.V., Konatham, P., 2029, Inconsistency in the frequency of rainfall events in the Indian summer monsoon season, International Journal of Climatology, 39 (13), pp. 4907-4923.

38.Rana, M., Singh, K.K., Kumari, N., Sanjay, J., Gohain, G.B., Kalra, N., 2019, Climate Change Impact and Response of Rice Yield, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 42 (3/W6), pp. 245-250.

39.Mohanty, U.C., Nageswararao, M.M., Sinha, P., Nair, A., Singh, A., Rai, R.K., Kar, S.C., Ramesh, K.J., Singh, K.K., Ghosh, K., Rathore, L.S., Sharma, R., Kumar, A., Dhekale, B.S., Maurya, R.K.S., Sahoo, R.K., Dash, G.P., 2019, Evaluation of performance of seasonal precipitation prediction at regional scale over India , Theoretical and Applied Climatology, 135 (3-4), pp. 1123-1142.

40.Rainfall Projections. http://www.imdpune.gov.in/endofseasonreport2013.pdf

41.Excel - Time Series Forecasting, http://www.youtube.com/watch?v=gHdYEZA50KE

42.Frequency Domain Using Excel. http://online.sfsu.edu/jtai/downloads/ENGR%20302/Excel.FFT.pdf

43.Sharan, A. M., and Balasubramanian, R., 1999, "Design of Four Bar Mechanisms by Neural Network Methods", Int. Journal of Modelling and Simulation, Vol.19, #1, pp. 1-6.

TABLE 1: RAIN FORECAST IN CENTIMETERS FOR JHARKHAND DURING 2025 MONSOON MONTHS

METHOD	YEAR	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL	COMMENTS
TIME SERIES	2025.0	7.2	19.8	32.1	19.8	78.9	
FFT	2025.0	31.6	35.5	28.8	20.3	116.2	
RMS	2025.0	8.8	29.1	30.0	21.8	89.6	
ANN	2025.0	8.9	27.3	27.5	20.0	83.6	
PREDICTED AVERAGE	2025	14.1	27.9	29.6	20.5	92.1	This year the predicted value is less than the 32 – year average shown below
32 YEAR AVERAGE	2025	18.9	31.4	29.8	21.8	101.8	

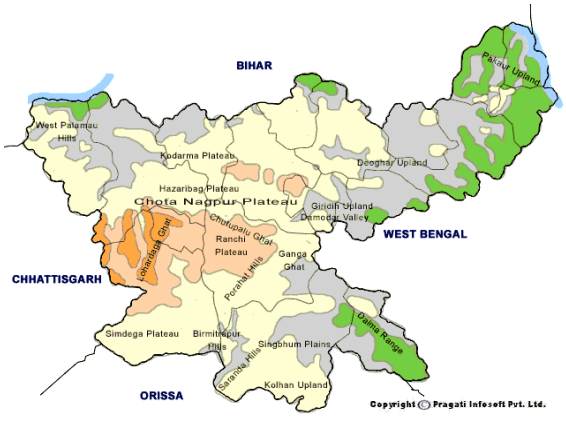

FIG 1 PHYSICAL MAP OF JHARKHAND, INDIA

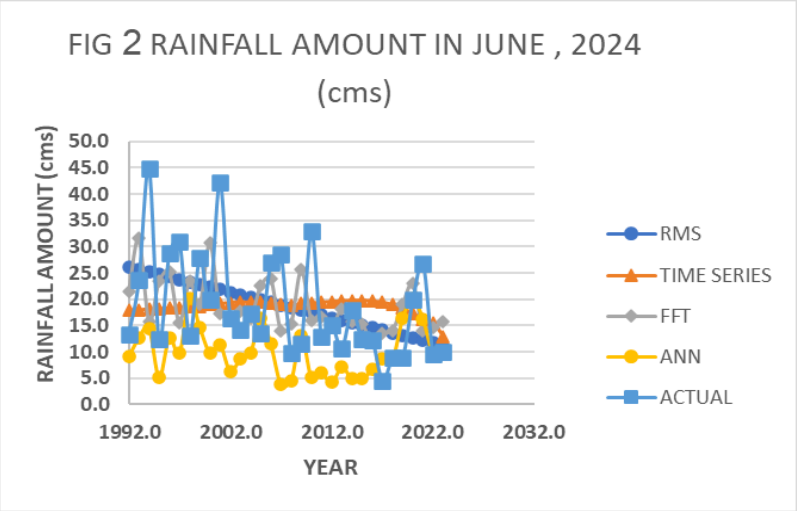
FIG 2 RAINFALL AMOUNT IN JUNE , 2024
(cms)
RAINFALL AMOUNT (cms)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1992.0
2002.0
2012.0
2022.0
2032.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL

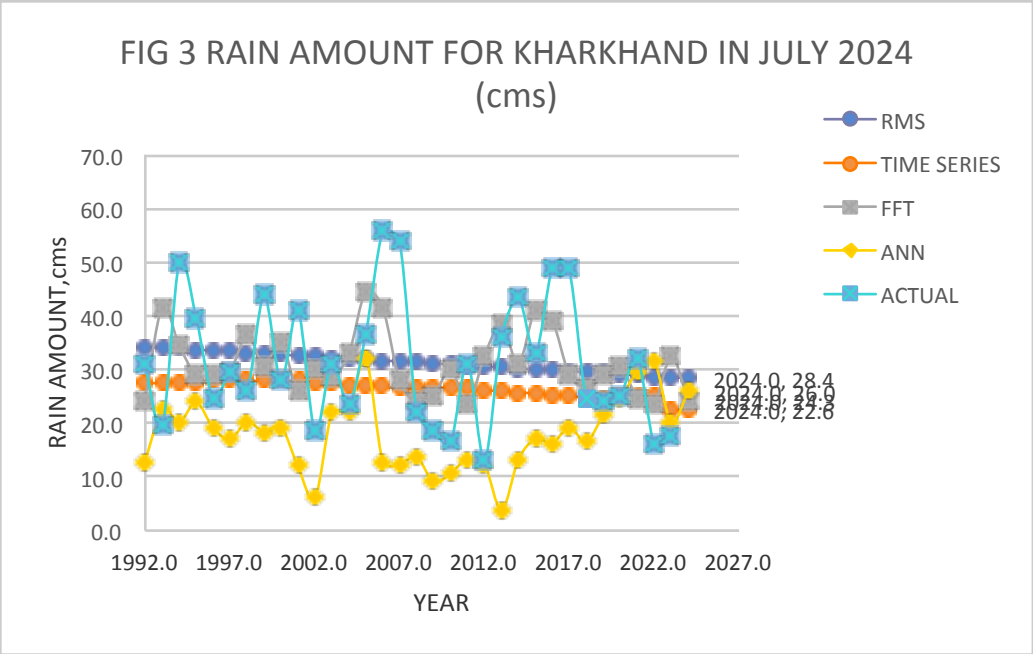
FIG 3 RAIN AMOUNT FOR KHARKHAND IN JULY 2024
(cms)
RAIN AMOUNT,cms
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1992.0
1997.0
2002.0
2007.0
2012.0
2017.0
2022.0
2027.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL
2024.0, 28.4
2024.0, 26.0
2024.0, 24.3
2024.0, 22.8

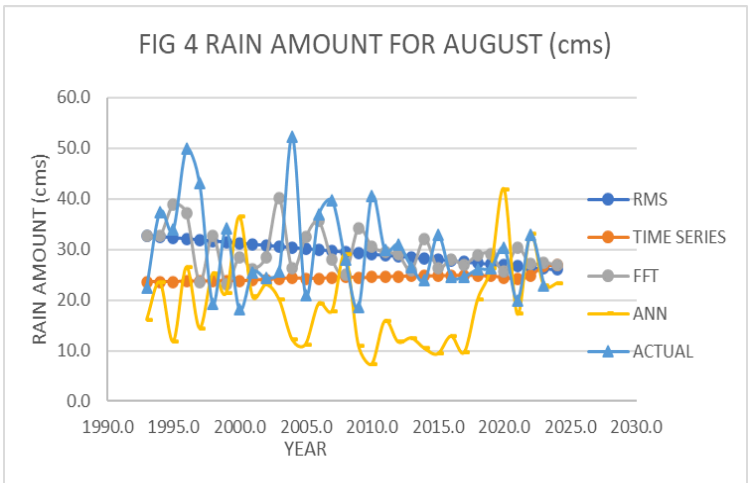
FIG 4 RAIN AMOUNT FOR AUGUST (cms)
RAIN AMOUNT (cms)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990.0
1995.0
2000.0
2005.0
2010.0
2015.0
2020.0
2025.0
2030.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL

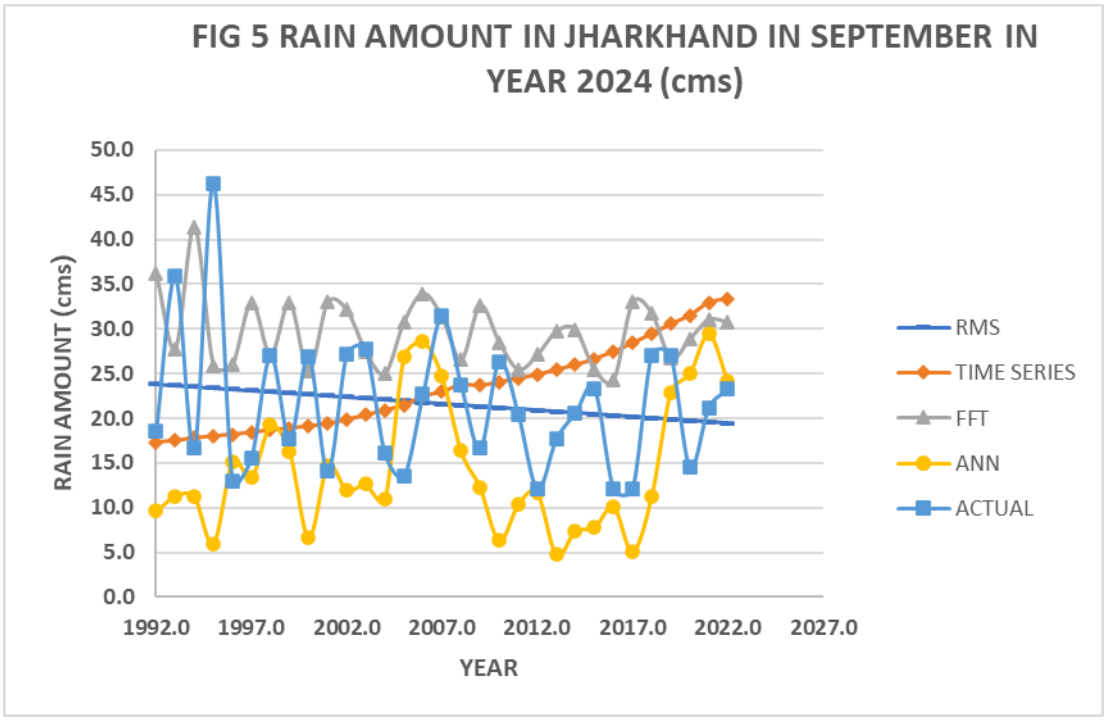
FIG 5 RAIN AMOUNT IN JHARKHAND IN SEPTEMBER IN YEAR 2024 (cms)
RAIN AMOUNT (cms)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1992.0
1997.0
2002.0
2007.0
2012.0
2017.0
2022.0
2027.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL

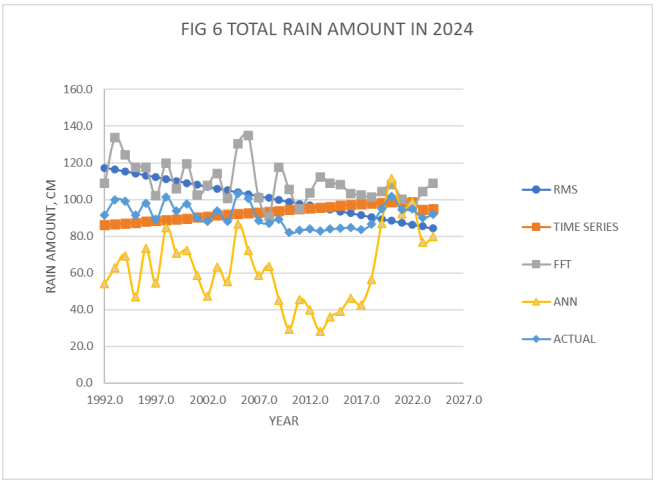
FIG 6 TOTAL RAIN AMOUNT IN 2024
RAIN AMOUNT, CM
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1992.0
1997.0
2002.0
2007.0
2012.0
2017.0
2022.0
2027.0
YEAR
RMS
TIME SERIES
FFT
ANN
ACTUAL

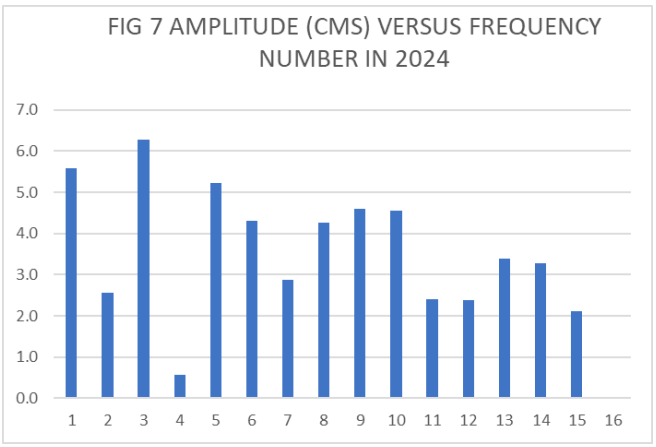
FIG 7 AMPLITUDE (CMS) VERSUS FREQUENCY NUMBER IN 2024
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16