

Original Research Article

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Potential and economics of Ragi (*Eleusine coracana* L. Gaertn.) cultivation under changing weather conditions of Ranchi, Jharkhand

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ABSTRACT

Jharkhand agricultural system is mainly dependent upon the weather conditions and the monsoon rainfall during the Kharif season. The state agricultural system is lagging behind because of low productivity, monocropping, erratic rainfall, and frequent dry spells. In addition to that, there is also a change in the weather pattern which will have a more significant negative impact on production and productivity of crops in the state, if the farming community continues with their indigenous practices. Ragi is a drought-tolerant and highly nutritional crop which has an economic value and productivity in the range of major cereals. The present study was conducted to find out the change in rainfall and temperature pattern of Ranchi as per the data available from 1950. Ragi variety, Birsa Madua-1, was tested for its productivity and economics in four villages of Ranchi under the weather conditions of Kharif season of 2018. It was concluded that there is a shift of rainfall in the district and rainfall period of Kharif crops is decreasing. There is also an increase in temperature and potential evapotranspiration. Ragi showed adaptability and stability even under the changing conditions with a B:C ratio of 2.28. Thus, it can be concluded that farmers should be made aware of the changing weather pattern and encourage them to cultivate ragi in order to combat the changing scenario.

Keywords

Weather change,
Rainfall,
Temperature,
Potential
evapotranspiration,
Substitute crop,
Ragi, Production
potential, B:C ratio

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Introduction

Weather condition is a key player in the agricultural system where it defines the type of crop to be grown under a particular set. Among the weather parameters, rainfall and temperature are the two most important ones which have a significant effect on the growth and production of a crop plant. Rainfall is a physical phenomenon of water transportation from the atmosphere back to the earth's surface (Shree and Kumar, 2018). Temperature, on the other hand, is the degree of hotness or coldness that is observed over an area over an interval of time. It depends on various processes such as radiation of the sun, the intensity of sunlight, cloudiness, suspended particulate material in air, etc. The knowledge of accurate trend of rainfall and temperature of an area can have a very good impact on the agriculture as we would be able to conform our farm practices according to it, in order to get maximum and sustainable production. In recent time, the world is observing a drastic change and variation in both the pattern of rainfall and temperature range which has resulted in many catastrophic crop failures.

Jharkhand is a relatively new state of India whose agricultural activities just like the rest of the country is dependent on rainfall brought by the south-west monsoon. It contributes to 85% of the rainfall in the state and success or failure of crops is directly proportional to the outset, advancement, and retraction of monsoon. The study of rainfall and temperature pattern from the recorded meteorological data have always been helpful in predicting the near future weather conditions. This, in turn, has aided in manipulating the agricultural practices in accordance to get optimum production. Thus, it is very crucial to find alternative crops which can be switched with the previously grown crops keeping in mind the changing

weather conditions. There is a transformation in the agricultural system of Jharkhand where high-value crops have been taken place of low-value crops (Singh and Prakash, 2017). The area under cultivation for previously grown crops such as rice and minor millets is declining and area of wheat, vegetables, and other horticultural crops is increasing. This change is feasible only with increased application of irrigation and chemical fertilizers in the agricultural fields along with the use of high-yielding and hybrid varieties. Although, this change has brought economic development and increased supply of agricultural produces, over-use of irrigation, chemical fertilizers, and soil exhaustive crop varieties are degrading the cropland of the state. So, there is a need to find out a crop which requires minimum irrigation and fertilizers, non-exhaustive to the soil, can sustain the changing weather conditions, and in the meantime does not slow-down the economic development as well as provide a similar amount of agricultural supply.

Eleusine coracana (L.) Gaertn., familiarly known as ragi or finger millet or madua is a very important minor-millet which is substantially grown in India and Africa as a staple food for a certain population (Devi *et al.*, 2014). It belongs to the Poaceae family and is an inhabitant of Ugandan and Ethiopian highlands (Adugna *et al.*, 2011). It is considered to be a model nutraceutical crop owing to its health benefits to humans (Gupta *et al.*, 2017). Many epidemiological researches have shown that routine consumption of ragi whole grain and its derived products lower the risk of type II diabetes, cardiovascular diseases, gastrointestinal cancers, and a number of other disorders (Mckeown *et al.*, 2002; Devi *et al.*, 2014). The whole ragi grain products contain ample amount of minerals, dietary fibres, vitamins, and phenolics which helps to combat hyperglycaemia and oxidative stress

(Antony *et al.*, 1996; Antony, 1998). The separated seed coat from grains of malting and milling ragi can be used as a constituent of special food supplement and as a whole, the nutrient content of ragi is comparable to mainstream cereals like rice, maize, wheat, barley, and bajra (Devi *et al.*, 2014).

Ragi is consumed in Jharkhand in different food preparations such as porridge, chapati, cake, cookies, kurha, and sweetmeat. In addition to these, boiled and malted germinated grains are used as a food supplement to infants and pregnant women as it does not form acids and is easy to digest. Ragi is considered to be one of the most nutritious, highly digestible, and least allergic food grain (Singh and Raghuvanshi, 2012). Apart from this, ragi has the ability to grow on least fertile soils without the application of chemical fertilizers, thus making itself suitable for cultivation in arid and semi-arid areas (Gull *et al.*, 2014). It is also considered as a drought-tolerant crop due to higher water use efficiency with enhanced fixation of CO₂ and minimal leaf area. Moreover, it is also utilizes soil nitrogen very efficiently and is resistant to various storage pests (Mgonja *et al.*, 2007; Gupta *et al.*, 2014, 2017). There is also increased recognition of ragi nowadays as a better food crop among consumers which presents an opportunity for the farming community to derive economic benefit from ragi production. All these characteristics of ragi make it a potential candidate as a substitution crop in the changing weather conditions of Jharkhand without hampering the economic returns and nutritive component.

The present study was thus conducted to study the pattern of rainfall and temperature pattern of Ranchi district of Jharkhand over a period of time, physicochemical properties of soil in that district, and production potential of ragi in that area under present weather conditions.

Materials and Methods

For the present study, Ranchi district of Jharkhand was selected and the monthly data of rainfall, minimum temperature, maximum temperature, diurnal temperature range, and potential evapotranspiration was collected from India Water Portal website (https://www.indiawaterportal.org/met_data/) and Metrological Observatory of ATMA, Ranchi. Four villages were selected for the field survey namely Husir (23.4602°N and 85.3343°E), Sukurhutu (23.4454855°N and 85.2903°E), Bukru (23.4809°N and 85.3080°E), and Patratoli (23.4350°N and 85.3337°E) that comes in area of Kanke in Ranchi district.

The soil samples were taken at a depth of 0-30cm from the experimental sites randomly and were subjected to the analysis of their physicochemical properties using standard procedures. Birsa Madua-1 variety was selected for the production potential test of ragi crop which is released from Birsa Agricultural University, Ranchi, Jharkhand. The crop variety was grown during Kharif season of 2018 in the experimental sites of selected villages and the obtained grains from each plot was sundried, cleaned, and weighed for data collection and further analysis.

Results and Discussion

Rainfall and temperature pattern from 1950 to 2002

From the data available on India Water Portal website, we can see that the rainfall (in mm) is mainly higher from the month of June to October with its highest intensities in July and August (Figure 1a and 1b). In the more current years, we can see that the rainfall is comparatively lower in the month of June and July while there is an increase during September and October. The amount of rainfall received during the Kharif season of

2018 is provided in Table 1. The monthly maximum and minimum temperature of Ranchi from 1950 to 2002 is depicted in Figure 2. From the pattern, it is seen that the maximum temperature (°C) is highest in the month of May followed by April, June, and March.

The minimum temperature (°C) was also observed highest in the month of May followed by June. However, it was seen that the minimum temperatures were higher in the month of July, August, September, and April. The monthly diurnal temperature range (°C) is shown in Figure 3. The figure shows that the temperature difference (°C) between the maximum and minimum temperatures is more in the months of March, April and May; while it is least in the months of August, July, September, and October. The potential

evapotranspiration (PET) (mm day⁻¹) of Ranchi is depicted in Figure 4. From the figure, we can clearly see that the highest PET is in the month of May followed by April, June, and March subsequently. The comparatively lower PET can be seen in the months of August and September.

Physicochemical properties of soil

The soil samples showed a clay-loam texture, were acidic in reaction, had low organic carbon, high availability of phosphorous, and medium availability of potassium. The detailed properties of the soil are given in table 2. The only deficient mineral in the soil was organic carbon otherwise, all the essential nutrients were present in sufficient quantities.

Table.1 Rainfall received in Ranchi during the Kharif season of 2018

Rainfall summary for month	Actual (mm)	Normal (mm)	Deficiency (Actual minus Normal) (mm)	Deviation (%)
				$\frac{(Actual - Normal) \times 100}{Normal}$
June	50.3	165.7	-115.4*	- 69.64*
July	170.7	323.7	-153*	-47.26*
August	126.8	322.9	-152.2*	-46.13*
September	117.2	214.3	-97.1*	-45.31*
October	18.6	64.6	-46*	-71.20*
Total	483.6	1091.2	-607.6*	-55.68*
Details of dry spells experienced (if any)	1)From:03 Jun to 22 June; number of days: 20 2)From: 06Jul to 16 July; number of days: 11 3)From: 07 Aug to 12 Aug; number of days: 06 4)From: 11Sept to 20 Sept; number of days: 10 5)From: 01Oct to 11 Oct; number of days: 11 6)From: 13Oct to 31 Oct; number of days: 19			
Delay in the onset of monsoon	Delay by 20 Days			
* - sign shows a decrease from normal				

Table.2 Physicochemical properties of the soil from the demonstrated fields

S.No	Parameter	Value	Unit	Result
I. Physical characteristics				
1.	Coarse sand	40-42	%	Sandy clay loam
2.	Fine sand	28-30	%	
3.	Silt	6-7	%	
4.	Clay	25-27	%	
II. Chemical characteristics				
1.	pH	4.5- 6		Acidic
2.	EC	0.05- 0.06	dS m ⁻¹	Sufficient
3.	Organic Carbon	0.40-0.43	%	Deficient
4.	Available N	380-385	kg ha ⁻¹	Sufficient
5.	Available P	18-21	kg ha ⁻¹	Sufficient
6.	Available K	140-145	kg ha ⁻¹	Sufficient
7.	Available S	30-32	ppm	Excess
8.	Available Zn	2.5- 2.7	ppm	Sufficient
9.	Available B	1.2- 1.3	ppm	Sufficient
10.	Available Fe	15- 16	ppm	Sufficient
11.	Available Mn	30-32	ppm	Sufficient
12.	Available Cu	2.35- 2.45	ppm	Sufficient

Table.3 Performance and Economics of Birsa Madua-1 (drought tolerant ragi variety) during Kharif, 2018

Plot	Area (ha)	Production (kg)	Yield (kg ha ⁻¹)	Gross Cost (₹ ha ⁻¹)	Gross Return (₹ ha ⁻¹)	Net Return (₹ ha ⁻¹)	B:C Ratio
Husir	3.23	12438	3850.77	20860	69314	48454	2.32
Sukurhutu	2.4	8564	3568.33	19750	64230	44480	2.25
Bukru	3.03	11402	3763.03	20530	67735	47205	2.29
Patratoli	1.82	7012	3852.47	21070	69344	48274	2.29
Total	10.48	39416	3761.06	-	-	-	-
Average						47103.25	2.28
<i>Grain selling price @ ₹ 18 kg⁻¹</i>							

Figure.1a Monthly rainfall (in mm) received in Ranchi from 1950 to 2002. (Date Source: India Water Portal)

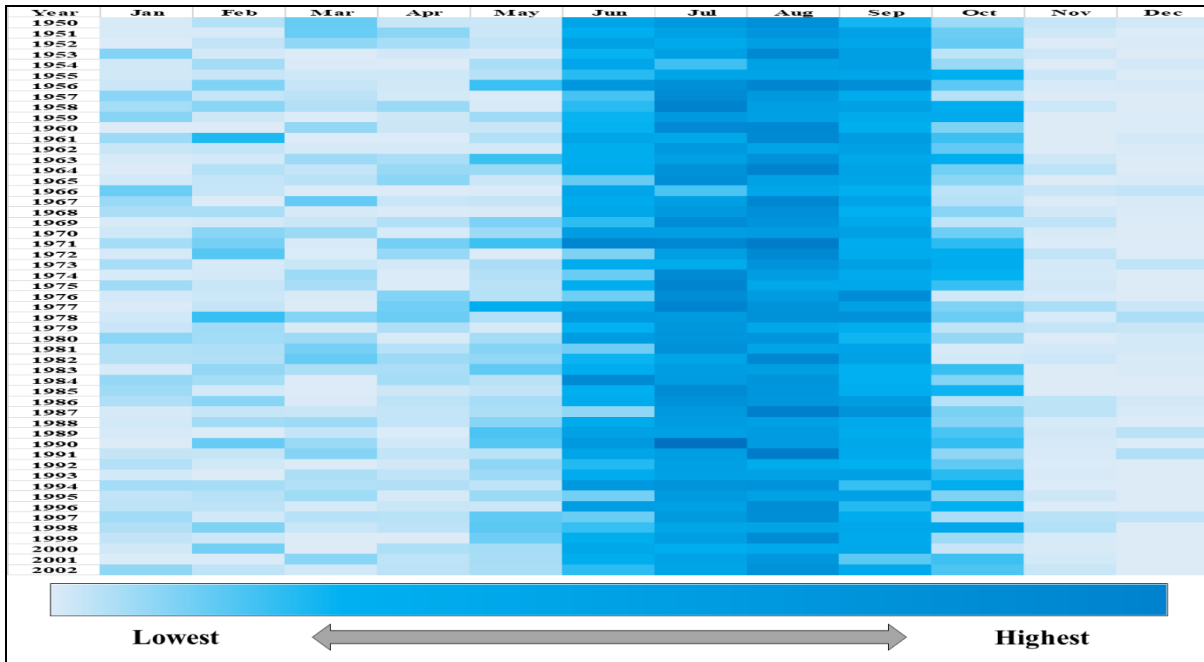


Figure.1b Rainfall (in mm) received in Ranchi from 1950 to 2002 in alternate months of the year. (Data Source: India Water Portal)

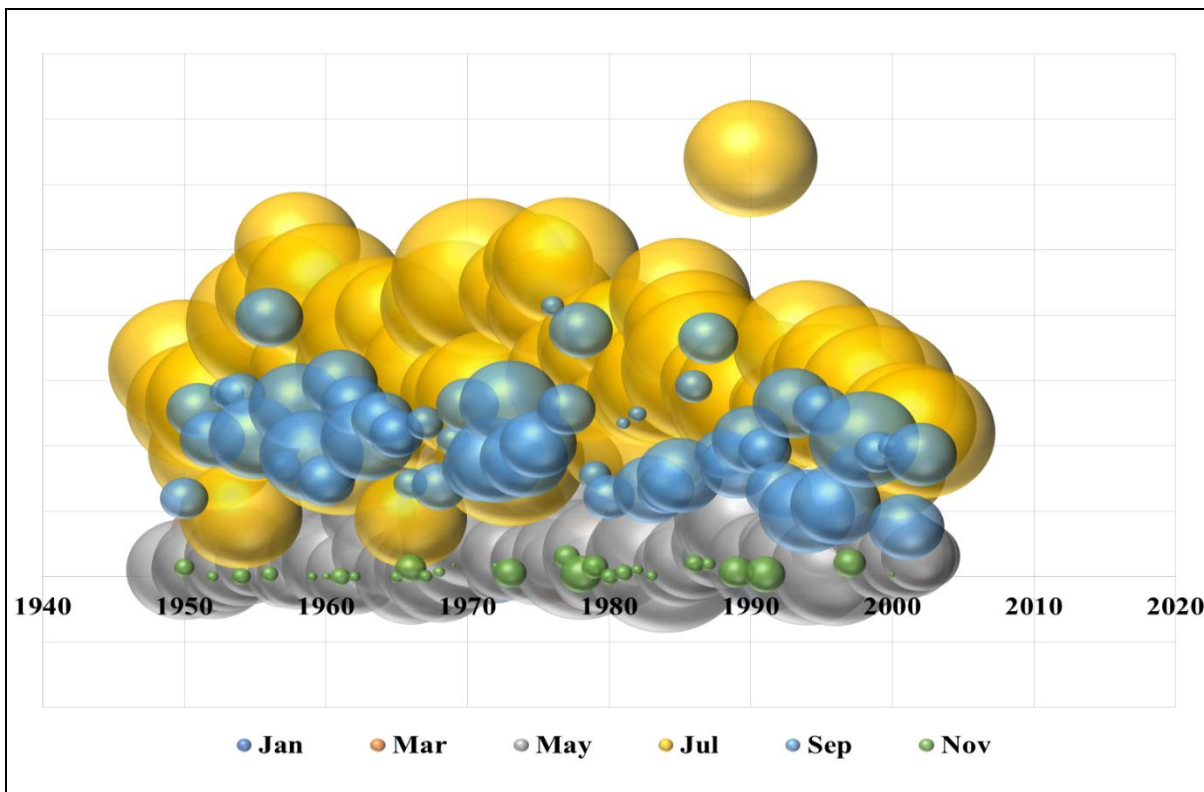


Figure.2 Monthly maximum (left) and minimum (right) temperatures recorded in Ranchi from 1950 to 2002 (Data Source: India Water Portal)

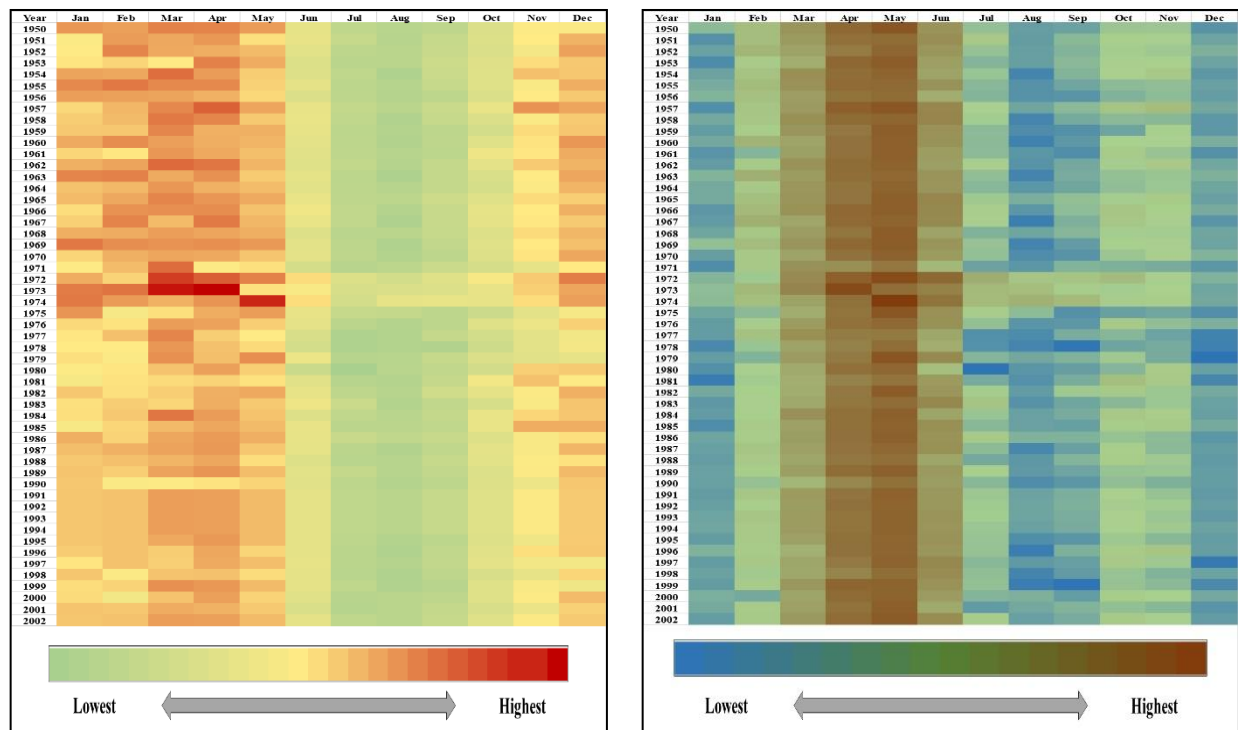


Figure.3 (Left) and **4** (Right): Monthly diurnal temperature range ($^{\circ}\text{C}$) and potential evapotranspiration (mm day^{-1}) of Ranchi from 1950 to 2002. (Data Source: India Water Portal)

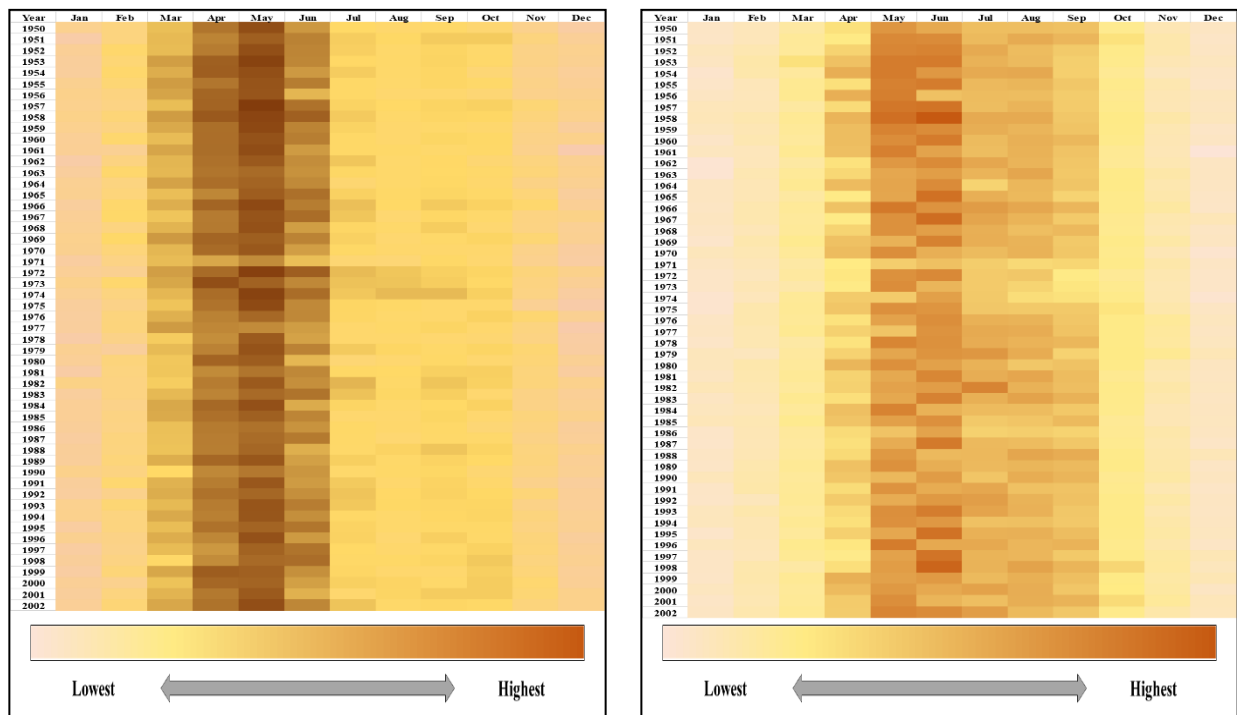


Figure 5: Birsa Madua-1 in different fields of four villages



Production potential of ragi

Birsa Madua-1 variety of ragi crop was grown in upland areas of four villages of Ranchi district during the Kharif season of 2018 (Figure 5). The performance of the ragi variety, Birsa Madua-1 under the seasonal conditions in selected villages is provided in table 3. It showed an average yield of 37.61 quintal ha⁻¹ from all the four selected villages and an average net return of ₹ 47,103.25 ha⁻¹. The cropping period received about 438.6 mm of rainfall which is 56.8% less than the normal rainfall of 1091.2 mm (Table 1). There were also five long-duration dry spells during crop growth period which was the main constraint in the crop's optimal performance. Even with such weather constraints, the average benefit-cost ratio of ragi cultivation in the four selected villages came about 2.28 (Table 3).

A calendar year can be divided into four major seasons viz: pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November), and winter (December to February) (Kumar *et al.*, 2009). It is clearly observed from the rainfall pattern that the intensity of rainfall during the monsoon period is decreasing while the post-monsoon rainfall is increasing slowly. The temperature and its fluctuations are also highest in April and May which is clearly visible from the monthly maximum and minimum temperature and monthly diurnal temperature range, respectively. The early Kharif seasons is thus marred with high temperatures and also less rainfall which could have detrimental effects on the production of crops grown during this season. The monthly potential evapotranspiration is also highest in the months of April, May, and June (Figure 4), which corresponds to the

increase in temperature. The loss of soil water is thus highest during this season, which is also an important factor in the context of Kharif crop production. All these changing conditions have made the farming community think about the contingent or substitution crop which can cope up with the weather aberrations without hampering the economics and sustenance. A proper crop planning has become a key step in the process of farming to mitigate the changing situations. The requirement of weather-based agriculture and their implementation has become a must.

The production study of drought-tolerant ragi variety, Birsa Madua-1, brings forward the fact that it can be used as the substitution crop in the state of Jharkhand. The crop can withstand the erratic rainfall pattern and requires fewer nutrients from the soil to flourish. Eventhough from the physicochemical properties of soil, it is very clear that soil in this region is very much able to fulfil the nutrient requirements of ragi crop. From the economic point of view, ragi is now very much in demand among the consumers which is changing it to a high-value crop and thus it is fetching higher prices to the farmers. As discussed earlier, ragi is very nutritive as it is designated as the model nutraceutical crop and has the production potential near to major cereals. These two characteristics match the statements of fulfilling agricultural demand of the people.

It is concluded that, there is a clear apparent change in rainfall and temperature pattern of Ranchi, Jharkhand which is compelling the agricultural community to come with relevant ideas to cope with it. One of the best solutions is substituting to the cultivation of ragi crop which shows better yield and economic returns under changing conditions. The cultivation of ragi should be encouraged in areas of Jharkhand where such weather alterations are taking place and have a similar agro-ecosystem to that of Ranchi.

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