

Agroclimatic approach

for improving sowing decisions

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For successful crop planning, farmers require information on the optimum crop sowing window. Traditionally, farmers take up sowing with the onset of monsoon during rainy (kharif) season, which may cause crop failure in the case of early season drought or break monsoon just after the onset. In this regard, to work out the onset dates of the crop growing season over 19 Agro-Ecological Regions (AER) of India, 3 methods, viz. Soil Water Balance, Depth and modified Morris and Zandesta methods were used. Soil Water Balance method was found to be the most suitable but it is data-intensive. Therefore, Modified threshold Combination (MTC) method comprising 40 combinations of rainfall information was employed to find out the onset dates. The results revealed that, in humid and per-humid regions, MTC criteria worked well, while in semi-arid and arid regions, onset dates outside of sowing window and false onset were found frequently. This necessitates further refinement of the criteria especially for the arid and semi-arid regions. The outcome of the present study will help the farmers and policy makers in planning and managing the agricultural activities.

Keywords: Crop growing season, Onset of monsoon, Sowing decisions

GLOBALLY, rain-dependent farming is being practiced in 80% of global arable land producing about 60% of food grains. The livelihood of 40% of India's population is supported by rainfed agriculture covering 50% of the net sown area of the country. More than 40% of country's food grain production and 65% of livestock population is supported by rainfed farming. Nevertheless, rainfed ecosystem possesses many challenges and risks, as Indian agriculture mainly depends on south-west monsoon (June–September), which contributes around 70–90% of the annual rainfall. The onset date of monsoon, its progress over the country, quantum of rainfall received and its distribution during the monsoon season are critical for determining higher agricultural output of the country. The unreliable features of south-west monsoon like break monsoon condition, irregular onset and withdrawal, variability in intra- and inter-seasonal rainfall are the causes of concern for the crops' performance, food/nutritional security as well as socio-economic development of the country.

Food and Agriculture Organization (FAO), Rome reported that the scope for expanding cultivable land

under irrigation is limited owing to increasing demand for water among different sectors. Therefore, it is very important to increase the crop production potential of rainfed farming for feeding the increasing population. However, success or failure of crop production under rainfed condition during rainy (*kharif*) season depends on the receipt of sufficient onset rains to take up the sowing operations. In general, farmers face crop failure/poor yields owing to unavailability of information on the start of the effective rainy season. India Meteorological Department (IMD), issues the forecast for onset of south-west monsoon over Kerala coast during April/May. The normal onset over Kerala coast is 01 June $\pm$ 7 days. The forecast of onset date is based on the rainfall, prevailing wind pattern and outgoing long-wave radiation. Whereas, to start agricultural sowing/planting activities, additional information on soil moisture status at root zone is necessary. The United States Agency for International development through its Famine Early Warning System (FEWS) programme also indicates that a monitoring tool which predicts precise information about onset of monsoon/rainy season is very much essential.

Agroclimatic approach for determining the onset

Agro-climatologists, agronomists and hydrologists put forth different criteria for finding start, end and length of rainy season. Across the world, many researchers determined the onset dates of rainy season based on several criteria like threshold rainfall amount, total available soil water/moisture, accumulated rainfall anomalies, percentage mean cumulative rainfall, rainfall-evapotranspiration (ET), water balance approach etc. Under Indian conditions also, several scientists have attempted to determine the onset date using daily/weekly rainfall, weekly soil water balance and evaporation. Nevertheless, these studies were conducted at few locations/regions of India, not covering whole India at district level and also did not validate with the ground level information. With this background, a study was carried out to ascertain the onset dates of crop growing season for different agro-ecological regions of India based on the method proposed by Sivakumar (1988). This is mainly because this method requires only the daily rainfall and very importantly includes false start criteria. The criteria, false start is very vital as dry-spell for a week or more after the initial wet-spell results in germination failure of the crop and re-sowing.

It was a challenging task to determine the starting date of crop growing season at agro-ecological region level for a country like India, as each region represents different climate (arid to per-humid), soil textural (sandy to clay) and multiple cropping systems. Due to this variability, working out the onset for the country based on same or single rainfall threshold may not

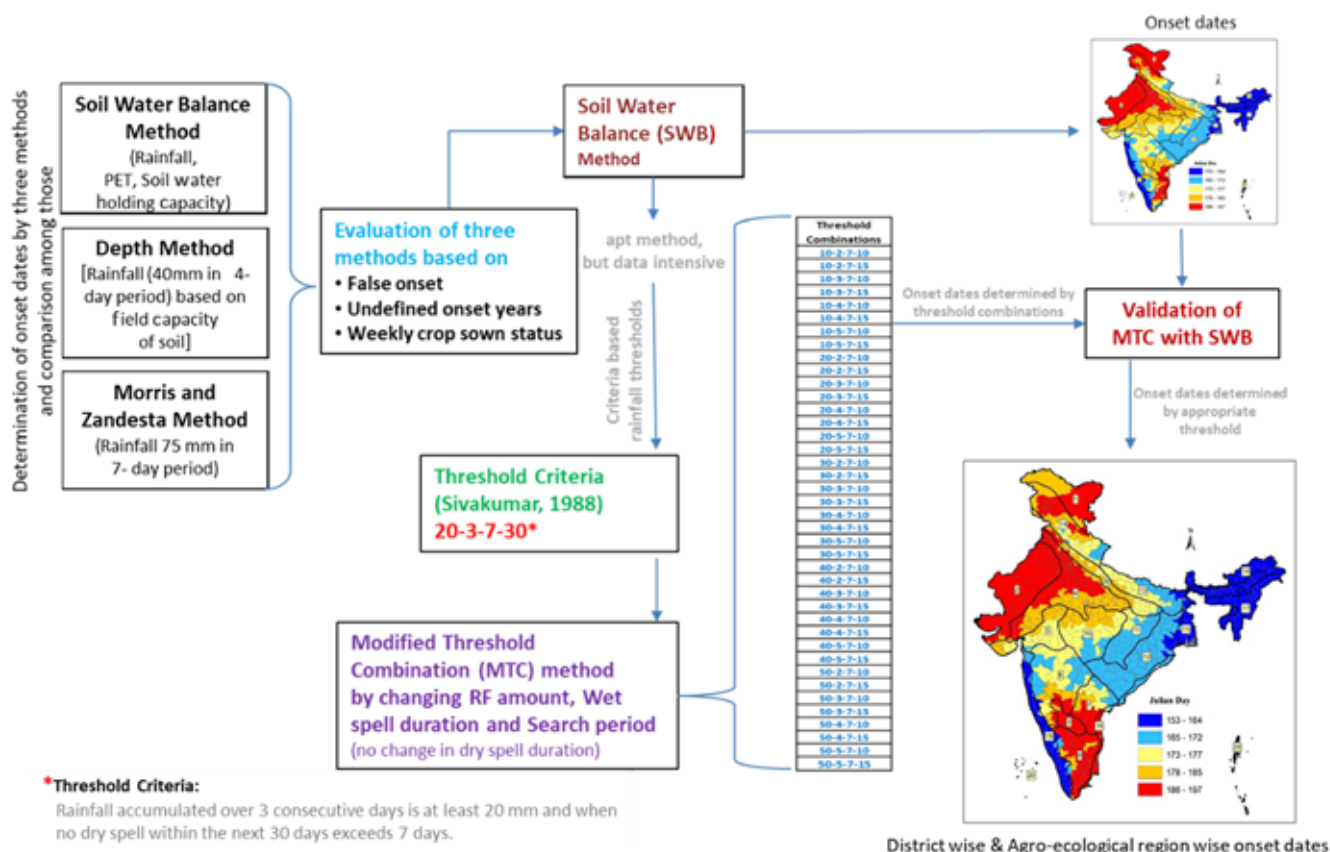
yield correct results. Hence, the onset of crop growing season was computed using MTC (Modified Threshold Combination) method consisting of 40 different combinations of rainfall information (rainfall amount, wet-spell duration, dry-spell duration and dry-spell search period) for 19 agro-ecological regions (AER) of India. The computed threshold combinations had to be corroborated against the suitable method.

Identifying the most suitable method

The most appropriate method among the three methods, viz. Soil Water Balance, Depth and modified Morris and Zandesta method was identified by comparing the onset date determined by the above three methods with the weekly crop sowing status, percentage of undefined years (onset date determined is beyond the last date of sowing window) and occurrence of false start (first wet-spell followed by long dry-spell for a week or more). The results indicated that Soil Water Balance is the most suitable method.

Identifying appropriate threshold combination for each Agroecological region (AER)

To find out the onset of crop growing season, Modified Threshold Combination (MTC) method comprising 40 combinations of rainfall information (Table 1) was considered. The onset dates determined by Soil Water Balance and MTC were compared using statistical indices to identify the appropriate threshold combination for each district of the AER. Further, the most frequent combination identified among the districts



*Threshold Criteria:

Rainfall accumulated over 3 consecutive days is at least 20 mm and when no dry spell within the next 30 days exceeds 7 days.

Methodology adopted for the study

Table 1. The identified threshold values for determining onset of crop growing season

Combination	Threshold values	Combination	Threshold values
1	10-2-7-10	21	30-4-7-10
2	10-2-7-15	22	30-4-7-15
3	10-3-7-10	23	30-5-7-10
4	10-3-7-15	24	30-5-7-15
5	10-4-7-10	25	40-2-7-10
6	10-4-7-15	26	40-2-7-15
7	10-5-7-10	27	40-3-7-10
8	10-5-7-15	28	40-3-7-15
9	20-2-7-10	29	40-4-7-10
10	20-2-7-15	30	40-4-7-15
11	20-3-7-10	31	40-5-7-10
12	20-3-7-15	32	40-5-7-15
13	20-4-7-10	33	50-2-7-10
14	20-4-7-15	34	50-2-7-15
15	20-5-7-10	35	50-3-7-10
16	20-5-7-15	36	50-3-7-15
17	30-2-7-10	37	50-4-7-10
18	30-2-7-15	38	50-4-7-15
19	30-3-7-10	39	50-5-7-10
20	30-3-7-15	40	50-5-7-15

10-2-7-10: 10, Rainfall amount (mm) during wet-spell; 2, wet-spell duration; 7, dry-spell duration; 10, dry-spell search period.

of the concerned AER was selected as the appropriate combination for the entire AER. From the results, it was also noticed that with increase in threshold amount of rainfall from 10–50 mm, the starting date as well as number of undefined years also increased.

Validation of onset dates

Statistical validation of onset date determined by MTC method with observed percentage of crop coverage showed that it is mostly close to the observed data. For the validation purpose, crop sowing status data on weekly basis was collected from the agriculture departments of the Andhra Pradesh, Gujarat and Rajasthan. The selected three states represented three different agro-ecological regions of India. It was found that, in many districts of Andhra Pradesh and Gujarat, early or late sowings were done by the farmers compared to the onset dates determined by MTC method. This is

mainly due to intra-district variations in rainfall, soil characteristics, socio-economic features, availability of irrigation sources etc.

In India, the earliest onset of crop growing season (Julian day 153–164 i.e. June 1–13) is noticed over west coast, West Bengal and entire north-eastern states. The onset progress over northern Andhra Pradesh, Telangana, Chhattisgarh, Odisha, Jharkhand and Bihar by Julian day 165–172 (June 14–21). Further, crop growing season starts in remaining parts of the country and finally by July 5–16 (Julian day 186–197) reaches over northwest parts of the country (parts of Gujarat, Rajasthan, west Uttar Pradesh), Jammu & Kashmir, Ladakh and southern Peninsula. One of the uniqueness of the MTC is having different thresholds of rainfall amount (10–50 mm), initial wet-spell duration (2–5 days) and dry-spell search period (10–15 days). The availability of multiple options allows to determine the onset of crop growing season in varied types of climatic situations i.e. arid to per-humid.

SUMMARY

Rainfall during monsoon plays a pivotal role in the livelihoods of farming community especially in the rainfed regions. The onset time, inter-and-intra-seasonal variations and withdrawal of monsoonal rainfall decides the economy of the countries located in monsoon regions. Any delay in arrival of monsoon may lead to significant drop in food grain production. The present study was carried out for determining agroclimatic onset of crop growing season over 19 agro-ecological regions of India. Statistical validation of the agroclimatic onset date ascertained by MTC method with observed percentage of crop coverage showed close agreement. Overall, it was found that in humid and per-humid regions, MTC criteria fit very well. However, in semi-arid and arid regions, number of onset dates outside the sowing window (undefined years) and false onset were frequently found. The outcome of the present study would help the planners, policy makers, extension officials and farmers in planning the agricultural activities. This is more important in the wake of climate change and variability posing a threat to Indian agriculture.

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Water

Even though households are relatively low consumers of water, population growth and expanded water use have outweighed the effect of water saving technology and behavior.

- Less than 3% of the world's water is fresh (drinkable), of which 2.5% is frozen in the Antarctica, Arctic and glaciers. Humanity must therefore rely on 0.5% for all of man's ecosystem's and fresh water needs.
- Man is polluting water faster than nature can recycle and purify water in rivers and lakes. More than one billion people still do not have access to fresh water.
- Excessive use of water contributes to the global water stress. Water is free from nature but the infrastructure needed to deliver it is expensive.

- See more at: <http://www.unep.org/wed/theme/water.asp#sthash.ki5vg3lB.dpuf>
Courtesy: United Nations Environment Programme website - <http://www.unep.org/wed>