

## Assessment of soil moisture storage from rainfall and its utility in Rabi crop planning in Haryana State

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**ABSTRACT.** An assessment of the accumulated soil moisture has been made during the sub-normal, normal and above normal years of rainfall over Haryana State. It was found that the accumulated soil moisture of 20 to 170 mm during the sub-normal years, 50 to 300 mm during the normal years, 100 to 500 mm during the above normal years exist from southwestern zone to the northern region of the State. The Rabi crop planning strategy has been formulated for optimisation of the yield with the given quantity of water available due to the existing rainfall patterns.

### 1. Introduction

Haryana State receives an annual rainfall of 300 to 1000 mm which constitute the dryland agriculture zone. The variability of rainfall mostly received in the period June to September is large, evaporation losses are high and the irrigation facilities exist over only 43 per cent of the cultivated land. A knowledge of the pattern of accumulated soil moisture storage is necessary to determine the nature of crop planning to be adopted, viz., Kharif vs Rabi, mixed vs Mono culture and double vs single cropping.

### 2. Method and data used

The daily rainfall data for the 56 State raingauge stations were collected over 20 - 30 years (1941-70) from the district headquarters of the State.

The most easiest approach to assess the moisture availability for crops is to analyse the distribution of rainfall in space and time. The total water availability period gives us a guideline for selecting suitable cropping patterns. Our moisture conservation practices should be such as to conserve maximum amount of rainfall during the southwest monsoon season. National Commission on Agriculture has made a systematic study of rainfall zones to demarcate the agro-climatic pattern of Haryana. It has been indicated that rainfall has the dominant influence in agriculture and it possesses stabler characteristics due to absence of trends of periodicity.

Raman and Venkataraman (1970) made an attempt to assess the probable soil moisture from daily falls of rain for the dry farming areas of Mysore State. The similar procedure was adopted to compute the probable soil moisture in the alluvial soils of Haryana State but with the following modifications :

- (i) The evaporative power of the air over Haryana in the Kharif season was taken as 7 mm.
- (ii) The maximum amount of evaporative loss from soil in a drying spell was taken as 25 mm instead of 18 mm.
- (iii) The total estimated moisture accumulation have not been assigned the limiting upper value determined by its field capacity so as to seek the possibilities of double cropping, long duration varieties and maximisation of the yield with the given quantity of available water.

During the SW monsoon months, the evaporation from the soil primarily depends on the evaporative power of the air. Rao *et al.* (1971) found that potential evaporation over Haryana (Lat. 28°-31°N, Long. 75°-77°E) was of the order of 7mm per day during the Kharif season (July to September). Mihsra (1949) found that the constant phase of evaporation was maintained for the first two days, and the evaporation depletion was 75, 50 and about 25 per cent of the potential evaporation on the

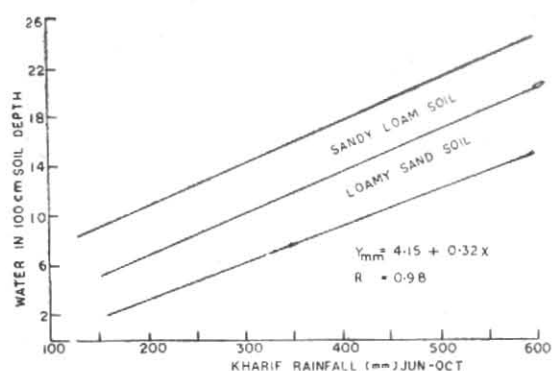


Fig. 1. Soil moisture storage in drylands in Haryana, Oct 1972

3rd, 4th and 5th day respectively of the initial wetting of the soil. These are considered synonymous with potential evaporation recorded with class A mesh covered pan evaporimeter during the rainy and winter seasons by Gangopadhyaya *et al.* (1969).

Therefore in computing moisture storage all daily falls of less than 7 mm were neglected and evaporative losses were allowed for 7 mm on first 2 days, 5 mm on 3rd day, 4 mm on 4th day and 2 mm on 5th day. The total evaporative depletion of 25 mm was found to give better estimates fitting the experimentally observed values (Section 3). For varying amount of precipitation, run-off was allowed on the basis of the findings reported by Kanitkar *et al.* (1960).

### 3. Experimental basis for the methodology

To test the validity of the above methodology for evaluating the soil moisture accumulation, soil moisture samples were taken on 16 October 1972 at the end of the southwest monsoon season around the 6 raingauge stations: Fatehabad, Hissar, Bhiwani, Dadri, Mahendragarh and Narnaul covering a range of 150 to 560 mm of Kharif rainfall. Ten bare moisture conserved spots were selected around each station. Soil moisture samples were taken upto 1 m depth. The soil samples were weighed in the field at the same moment in order to avoid any loss of moisture due to evaporation. The data given in Table 1 reveal that the assessed accumulated soil moisture from rainfall data closely agree with the amount of water stored in the soil profile due to the southwest monsoon rainfall. A regression equation of the type  $Y=4.15+0.32X$  was found to hold true at  $r=0.98$ , where  $X$  is the Kharif rainfall in mm and  $Y$  is the amount of water in mm available in 1 metre soil profile. The graphical picture shown in Fig. 1 holds promise of knowing from the amount of Kharif rainfall and the soil type of a particular location, the amount of the stored moisture.

TABLE 1  
Analysis of soil moisture data

Station	Average amount of soil moisture (%)	Average amount of water present at the		Amount of water stored during monsoon (mm)	ACC. moisture assessed from rainfall (mm)
		end of monsoon (mm)	before onset of monsoon (mm)		
Hissar	4.2	60.9	32.0	28.9	30.0
Fatehabad	4.1	59.4	32.0	27.4	28.8
Bhiwani	4.3	62.4	32.0	30.4	33.0
Dadri	8.1	113.4	31.5	81.9	83.0
Mohindergarh	8.8	123.2	31.5	91.7	94.0
Narnaul	11.2	156.8	31.5	125.3	130.0

TABLE 2

Classification of years by the amount of rainfall in Haryana

Stations*	Years of rainfall		
	Sub-normal <75 %	Normal	Above normal >125 %
Hissar	30	42	28
Sirsa	30	44	26
Bhiwani	23	47	30
Jind	16	50	34
Gurgaon	22	65	13
Bawal	30	40	30
Narnaul	23	59	18
Sonepat	20	56	24
Karnal	9	82	9
Palwal	22	53	25
Thanesar	9	73	18
Ferozpur Zhirka	22	56	22
Ambala	11	78	11
Jagadhri	20	54	26
Nariangarh	25	57	19
Charkhi dadri	38	34	28

\*Only selected stations have been reported in the different zones

### 4. Results and Discussion

The soil moisture storage was assessed (Table 2) according to the classifications of rainfall amount, i.e., during the sub-normal years (<75 per cent of the normal rainfall), normal years, and above normal years (>125 per cent of the normal rainfall). The spatial distribution of the accumulated

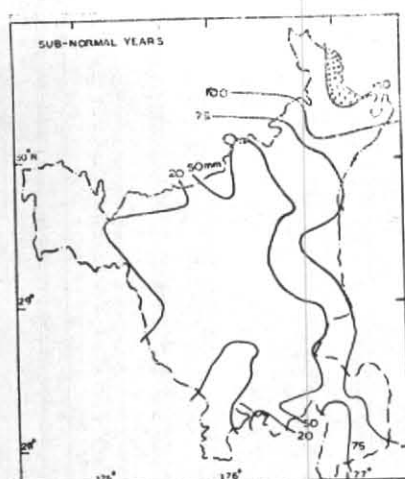


Fig. 2

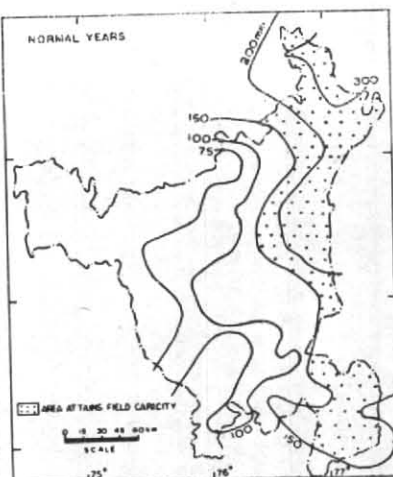


Fig. 3

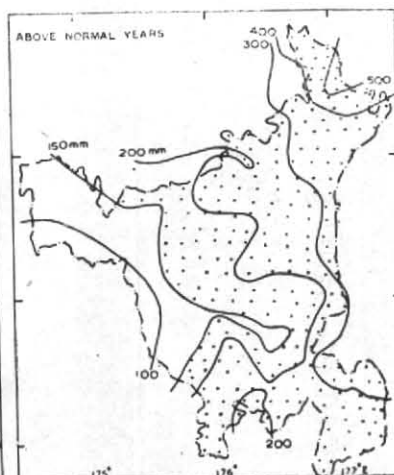


Fig. 4

Soil moisture storage during sub-normal, normal and above normal years in Haryana State

**TABLE 3**

Soil moisture storage and Rabi crop planning during sub-normal years in Haryana

Soil moisture storage (mm)	Winter rainfall (mm)	Area under storage	Crops
>150	150	Nariangarh and Raipur Rani	Sarson, Gram, Barley
100-130	100-150	Ambala, Jagadhri Chandigarh, Kalka	Raya, Sarson, Gram
75-100	60-100	Southwestern Ambala, Panipat, Ballabgarh, Palwal and Sohna	Raya, Taramira, Sarson
<75	60	Rest of Haryana	Taramira, Raya

soil moisture storage during sub-normal years, normal years, and above normal years is shown in Figs. 2, 3 and 4 respectively. It is clearly indicated that the soil moisture storage depends on the rainfall pattern. The storage figures in these diagrams are applicable to the bare soil of unlimited depth, but has a limiting value of 150 mm for the predominantly sandy loam soils of Haryana. But this limiting value has not been assigned because the excess amount of water could be utilised by the Kharif crop. Thus the possibilities of double cropping or the long duration varieties like sunflower, arhar, castor, or a combination of short and long duration varieties can be evaluated. It is seen that during the deficit years in the driest southwestern portion of Haryana, the soil moisture is 20 to 50 mm, during normal years,

**TABLE 4**

Soil moisture storage and Rabi crop planning during normal rainfall years in Haryana

Soil moisture storage (mm)	Winter rainfall (mm)	Area under soil moisture regime	Crops
>300	150	Nariangarh, Kalka, Chandigarh, Raipur Rani	Gram, Barley, Wheat. Bajra/ Guar / Cowpeas /-Raya / Sarson/ Gram
200-300	100	East Ambala, Jagadhri, Karnal, Panipat	Gram, Barley, Wheat. Bajra/ Moong /-Taramira / Raya
150-200	60-100	East Thanesar, Sonapat, Delhi, Gurgaon, Sohna, Ballabgarh, Riwari, Nuh, Hathin, Punhana and Hasanpur	Sarson, Gram, Barley
100-150	50-60	Thanesar, Rajound, Jind, Jamni, Rohtak, Gohana, Samplam, Pataudi, Tatusana, Tauru, Bawal, Dadri, Mohendergarh, Narnaul, Farrukhanagar, Ferozepur zhirka, Palwal.	Raya, Sarson
75-100	40-50	Kaithal, Narwana, Dhakhhal, Tarkha, Hissar, Hansi, Bhiwani, Loharu, Beri, Salhawas, Khol	Raya, Taramira, Sarson
<75	40-50	Badrikri, Tohana, Sirsa, Fatehabad, Siwani, Rania, Dabwali	Raya, Taramira

TABLE 5  
Soil moisture storage and Rabi crop planning during above normal years in Haryana

Soil moisture storage (mm)	Winter rainfall (mm)	Area under soil moisture regime	Crops
>400	150	Nariangarh, Kalka, Chandigarh	Wheat, Barley, Gram, Bajra/ Guar/ Moong/ Cowpeas/ Sarson/ Gram/Barley
300-400	70-150	Gurgaon, Ballabgarh, Delhi, Panipat, Karnal Thanesar, Jagadhri, Ambala	Gram, Barley, Wheat, Bajra/ Guar/ Moong/ Cowpeas-Raya/ sarson, Moong-Gram
200-300	50-70	Badrikari, Sonapat, Farukhnagar, Dadri, Mohinder- garh, Narnaul, Jatusana, Rewari, Pataudi, Bawal, Taruh, Sohna, Nuh, Hathin, Palwal, Feroze- pur zhirka, Pulhana, Hasanpur	Gram, Barley, Bajra/Moong- Taramira/Raya
150-200	50-60	Gulah, Tohana, Kurar, Tarkha, Hissar, Hansi, Tohana, Rohtak, Sampla, Jhajjar, Salawas	Raya, Sarson, Gram
100-150	40-50	Sirsa, Fatehabad, Beri, Bhiwani, Loharu	Sarson, Raya
<100	30-40	Siwani, Southern Sirsa	Taramira, Raya

70 to 100 mm, whereas in the exceptional above normal years it amounts to 150 mm. In the wetter zones, normal year contribute to field capacity stage, whereas above normal years contribute to ground water recharge. In the deficit years, the wetter zones accumulate a moisture storage from 100 to 170 mm.

The optimisation of yield with the given quantity of water due to the conserved moisture during the SW monsoon season and the winter rainfall is highly desirable under dryland agriculture. A crop planning with the available moisture during the different climatic conditions has been depicted in Tables 3, 4 and 5 and their brief description is as follows :

(i) *Rabi crop planning during deficient years* — During sub-normal years, sarson, gram, barley and raya can be grown in Ambala district, Panipat, Palwal and Sohna areas; whereas for the rest of Haryana only crops like raya/taramira can successfully be taken under the rainfed situations. Under the conditions, the upper soil layer becomes completely dry and it would be very difficult to sow the crops; therefore, a ridger-cum-seeder type of an engineering implement would be highly desirable to prepare the ridges and simultaneously the seed will be put in the furrows to have the contact with the moist layer.

(ii) *Rabi crop planning during the normal years* — During normal years crops like gram, barley, wheat and double crops such as bajra/guar/cowpeas/moong-raya/sarson/gram are feasible in the Ambala district, Karnal and Panipat under the rainfed conditions. For the rest of Haryana raya, sarson and taramira can be grown under the rainfed conditions. It would be highly desirable to evolve suitable varieties having low water requirements under the existing conditions.

(iii) *Rabi crop planning during the above normal years* — During such years, crops like wheat, gram, barley and double crops such as bajra/guar/cowpeas/moong-sarson/gram/barley are possible in the Ambala district, Karnal, Kurukshetra, Gurgaon, Ballabgarh, Delhi and Panipat. In Siwani and southern Sirsa only taramira and raya crops are possible. For the rest of Haryana, crops like gram, barley, sarson can successfully be raised under the rainfed conditions.

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