Characterization of Rainfall in the Low Country Wet Zone in Terms of Crop Water Requirements of Annual Field Crops

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ABSTRACT

It is observed that many lowland paddy fields are left for fallow during the Yala season in the low country wet zone of Sri Lanka. One of the main reasons for this fallowing is the lack of water for irrigation. Since streams, which supply irrigation water to these paddy fields, dry up soon after rainstorms, the risk of water shortage for irrigation is high. The high risk has compelled farmers to give up Yala season rice cultivation. However, as the water requirements of the field crops are generally low, great potential remains for diversification of these paddy fields with other field crops (OFC) during Yala season. Characterization of rainfall of the area in terms of possibility of meeting the crop water requirements is a pre-requisite for development of a suitable cropping pattern for the area. Such an exercise will help identify the periods of water shortage and water excess compared to water requirements of crops. This exercise will also help development of water resources at farm level for agricultural use. Water resource development at farm level should look into irrigation and field drainage problems. This paper presents results of analysis of weekly rainfall of Ratnapura and Bombuwela in order to find out possibility of meeting potential evapotranspiration (PET) of some annual crops in the low country wet zone. Attempts were made to identify the periods where rainfall exceeds the PET and periods when rainfall falls below PET. The analysis showed that excess water is a limitation for growing OFC in area represented by Ratnapura. In the area represented by Bombuwela rainfall characteristics during period from mid February to end of August can be considered suitable for growing OFC. However, supplementary irrigation and drainage facilities become two essential requirements for such an exercise.

INTRODUCTION

The percapita land availability in Sri Lanka continues to decline with the population growth. The present percapita land availability is about 0.36 ha. The percapita land availability with regard to arable lands is half of this. Under this situation improving the productivity of available land is one of the most important task ahead of us. FAO has alarmed that there going to be a famine in the near future. Food security has been a slogan of FAO at present. Under this context it is very important to identify the lands where the productivity is low, find out the reason for problems and develop ways and means by which productivity can be improved. Paddy fields in low country wet zone has been identified as having low cropping intensity. The statistics on cultivated extents of paddy showed that in Yala 1995 only 54% of the paddy lands of low country wet zone districts namely Colombo, Gampaha, Kalutara, Galle, Matara, Kegalle and Ratnapura was cultivated. Insufficient water availability for growing paddy in Yala season and low profitability of paddy cultivation are the reasons attributed to fallowing of lands in this region. Introduction of alternate crops and cropping systems to improve the land productivity may help to put the paddy lands back to cultivation. A pre-requisite for such an exercise is the assessment of the water resource to determine the potential for various crops and cropping patterns. The objective of this paper is to assess the rainfall characteristics of the low country wet zone in relation to water requirements of annual field crops.

METHODOLOGY

This study was aimed at paddy fields in the low country wet zone region. The climatic data available for estimation of evapotranspiration of crops is very much limited in this area. Data were available only in two meteorological stations namely Ratnapura (6°40'N 80°25'E) and Bombuwela (6°32'N 80°E). Therefore data of these two stations were used for the analysis. Weekly mean data for 20 years (1977 - 1997) from meteorological station at Bombuwela and 21 years (1976-1997) from the meteorological station at Ratnapura were used. Weekly rainfall data were used for rainfall probability calculations. As normal distribution of rainfall of standard weeks was not associated with rainfall data, quintile method was used in estimation procedures (Doorenbos and Pruitt, 1984).

Potential Evapotranspiration (PET) was calculated using modified Penman equation (Doorenbos, 1997). Weekly averages of maximum and minimum temperature, day and night relative humidity, sunshine hours and wind velocity were used in this calculation. Weekly PET calculated for the respective periods were used to estimate probability. Quintile method was used. Ratio of rainfall at 75 % probability level to PET at 75 % probability level was used in determining water adequacy /inadequacy for meeting water requirements of various crops.

RESULTS

Climate: Rainfall temperature and solar radiation are the main variables of crop growth. Humidity is a factor, which has greater relationship on disease incidence of the crops. The data of these variables of that two stations indicate that there are no major limitations of temperature, radiation and RH for growth of the crops in the area. However, the rainfall seems to be highly variable and this seems to be the most important variables, which could limit the crop production through its effect on meeting the water requirements of the crops.

Rainfall: Weekly rainfall distribution at 75% probability level for the two stations are given in figure 01. For agricultural planning 75% probability of rainfall has been suggested (Pannabokke and Walgama 1974) From 75% probability rainfall distribution prominent period with very low rainfall could be identified at both stations. The duration of these periods at two stations were different. At Ratnapura it was about 9 weeks long starting from 1st week of the year. At Bombuwela it was 13 weeks long starting from 1st week of the year. Another similar very low rainfall period of 2 weeks could be identified around 32 and 33 week at Bombuwela but this period is not prominent in Ratnapura. These low rainfall periods could be considered as dry periods in the area

Two prominent rainy periods are also identified at both stations. The lengths of them were different at the two stations. These two rainy periods are in Yala and Maha seasons. The length of the 1st rainy period is about 22 weeks long from 9th week to 31st week at Ratnapura and about 19 weeks from 13th week to 32nd week at Bombuwela. The second rainy period begins soon after the 1st period without leaving a prominent dry period at Ratnapura. The length of second rainy period is from 31st week to about 49th week at both stations. During both rainy periods the weekly rainfall at Ratnapura exceed than that at Bombuwela.

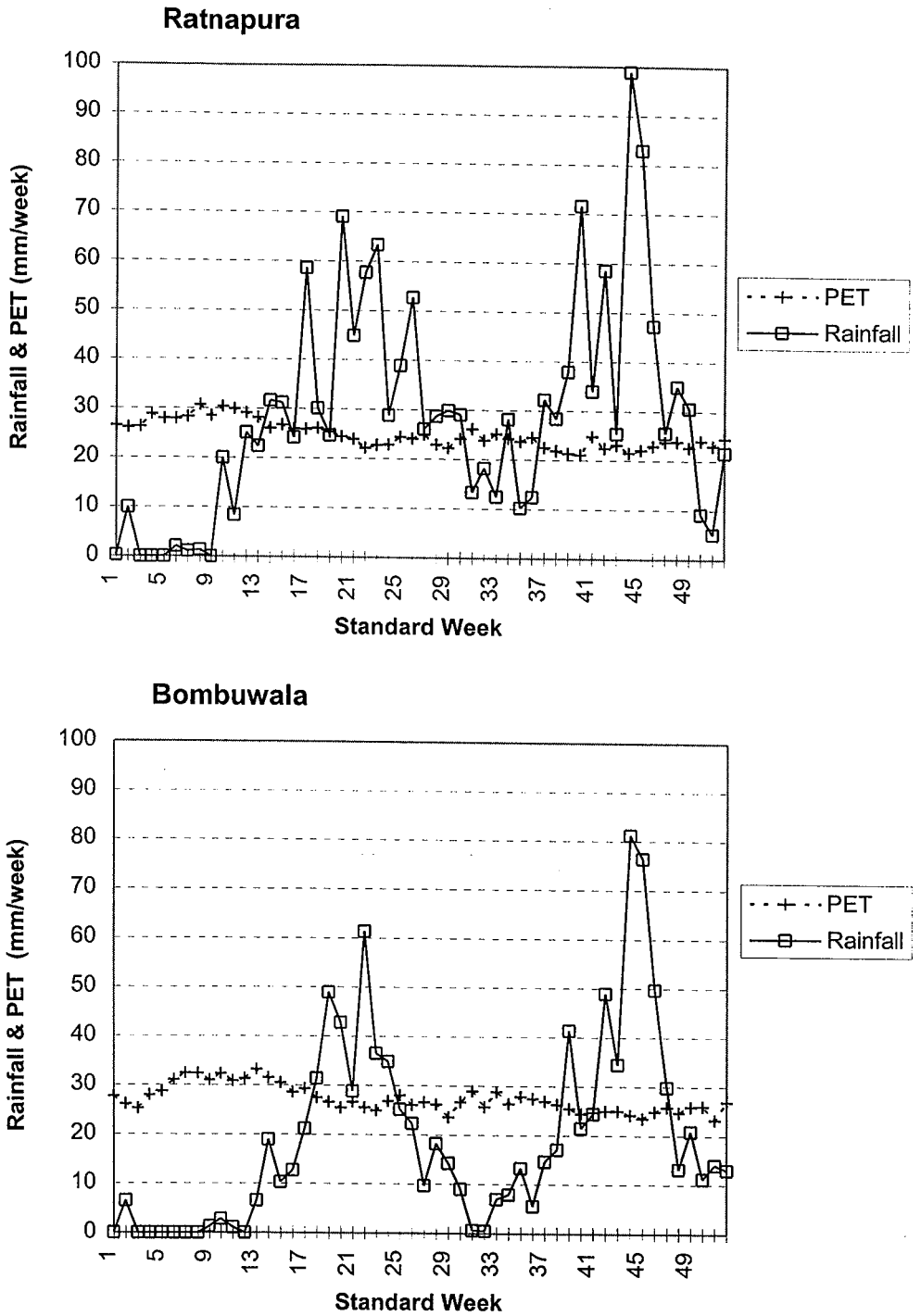

Figure 01: Rainfall and Potential Evapotranspiration at 75% Probability at Ratnapura and Bombuwela

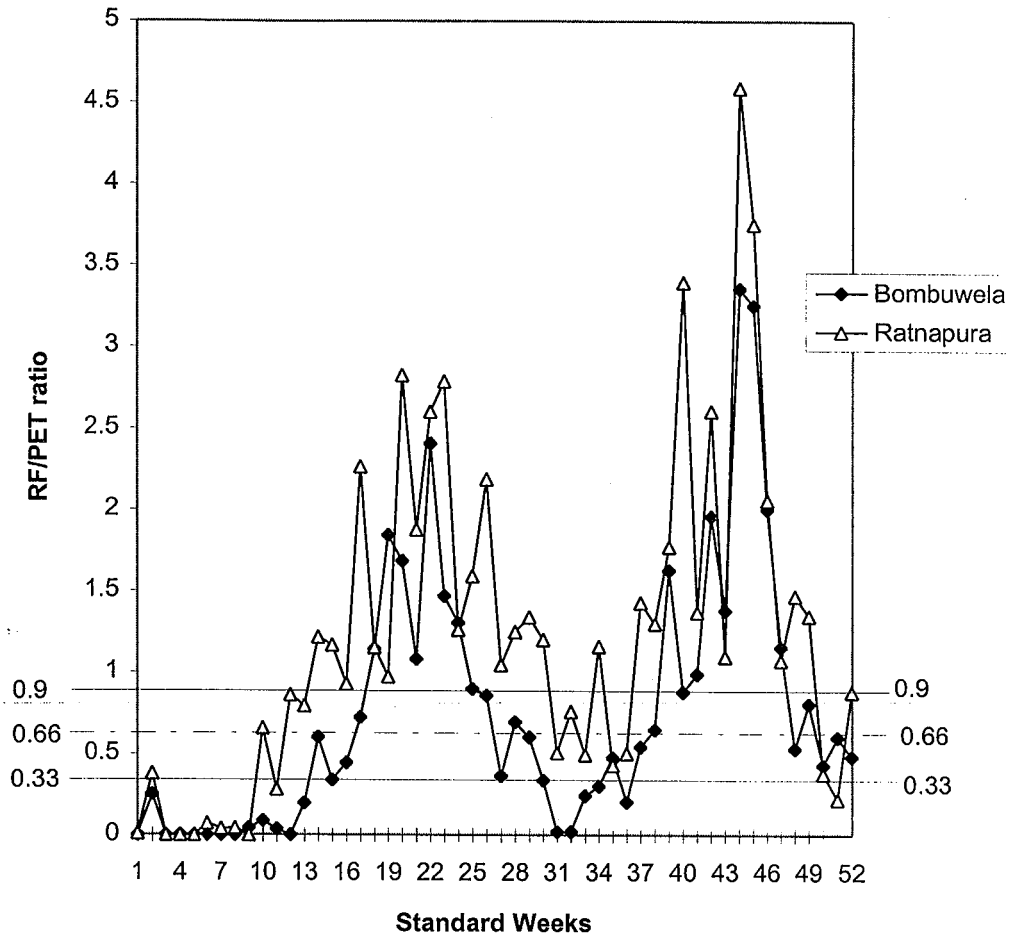

Figure 02. Variation of RF/PET Ratio over the Year at Ratnapura and Bombuwela

Potential Evapotranspiration: The change of potential ET of 75% probability level over the year at the two stations is given is figure 01. The pattern of change is more or less the same. However, the rates at Bombuwela seems to be higher than that at Ratnapura in some months. The mean annual PET at Ratnapura was 24 mm/week while it was 27 mm/week at Bombuwela. The PET at Ratnapura and Bombuwela ranged between 21-31 mm/week and 24-32 mm/week respectively. Two periods where rainfall (RF) below PET and two periods where RF is above PET could be identified at both stations. The length of these periods at the two stations are different. The 1st period where RF<PET at Bombuwela is from 48 th week to 18 th week; a period of 5 months. The 2 nd period is from 26 th week till 39 th week; a period of 3 months. At Ratnapura the comparable periods are; the 1st period is from 48 th week till 13 th week; a period of about 4 months. The second period is from 29 th week till 36 th week; a period of about 2 months. Unlike the rainfall, the PET remains more or less same over the year.

Hargreaves (1974, quoted by Kannangara,, R.P.K., Rainfall climatology of selected locations in the dry zone of Sri Lanka, Unpublished) used RF/PET ratio (RF= rainfall at 75% probability) for determining adequacy of rainfall for growing rainfed crops. If the ratio is above 0.99, the period is considered very wet and suitable for low land crops and paddy. The period when the ratio is 0.66-0.99 maize can be grown with improved drainage. If the ratio is 0.33-0.66 there is adequate moisture to grow maize, sorghum and pulses. The periods with the ratio below 0.33, moisture is deficit for growing under rainfed conditions. This criteria could be applied to identify period suitable for growing different crops in the low country wet zone. The variation of RF/PET ratio during the year is given in figure 02. The periods where the ratio > 0.99 is given below for different stations.

Period	Station	Standard week No.	Duration Weeks (Months)
1	Ratnapura	13-31	18 (4.5)
	Bombuwela	18-26	8 (2)
2	Ratnapura	30-50	12 (3)
	Bombuwela	38-47	9 (2.25)

The length of the period seems to be not adequate at Bombuwela for growing paddy as rainfed crop in both seasons. However,, as there is water for supplementary irrigation for about two months following Maha rains paddy could be grown in Maha season in this area. During Yala season (Period 1) however, as the Yala rainfall is not high as in Maha season there is no adequate water for irrigation following rain period and the duration with RF > PET is not sufficient to grow rice crop of even 3 months age class without adequate irrigation. There is no problem of growing rice in Ratnapura in both seasons. The period where RF/PET ratio < 0.33 is about 6 weeks long at both station extending through 3rd - 9th weeks. According to the figure 02, there is no period with sufficient length (at least 3 months) where RF/PET = .33 - .99 to grow other field crops. Therefore growing period of these crops have to be considered to be extended in to moisture deficit periods (with irrigation) and moisture excess periods (with adequate drainage). According to the data given in figure 02 there is no much scope for growing field crops in areas represented by Ratnapura station because of wet conditions. In the case of areas represented by Bombuwela, there is no much scope for Yala season Paddy cultivation. Therefore periods from mid February (6th

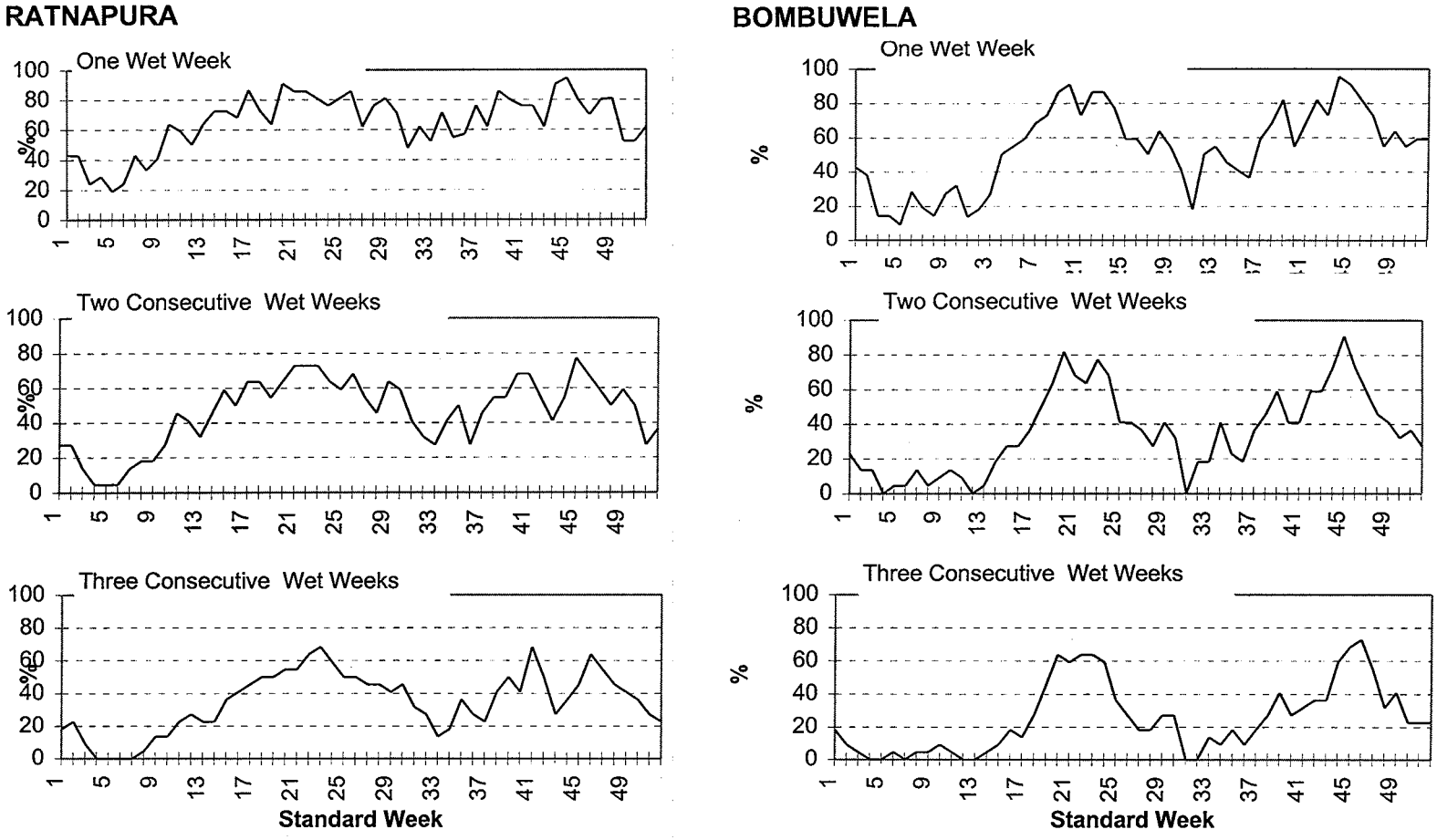

Figure 03 :Probability of Occuring Wet Periods[1] at Ratnapura and Bombuwela

1 Wet : rainfall > potential evapotranspiration (RF > PET)

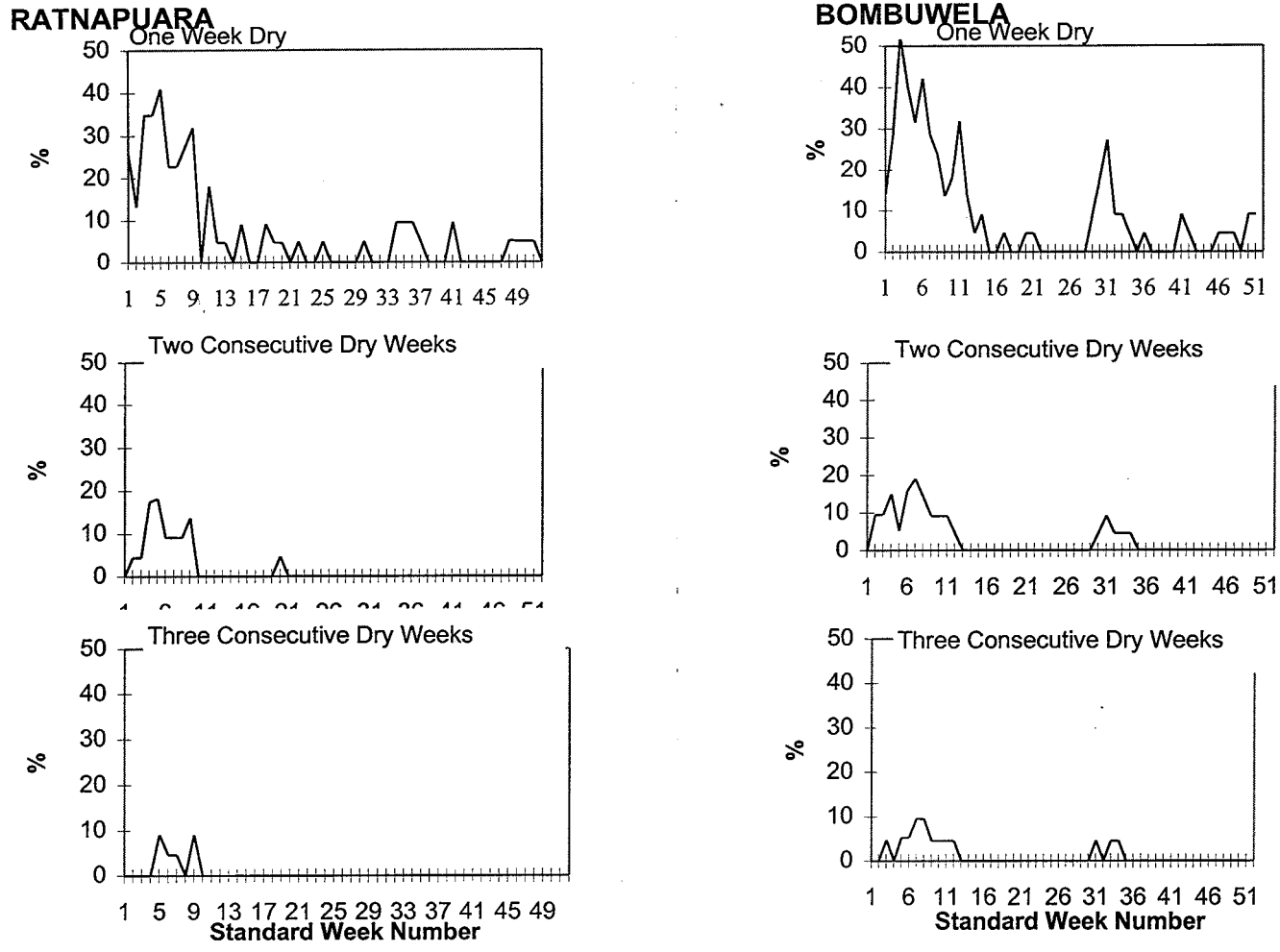

Figure 04 : Probability of Occuring Dry Periods[2] - Ratnapura & Bombuwela

2 Dry = periods with zero rainfall

week) to mid September (36th week) can be considered for growing field crops with provision of irrigation and drainage facilities.

Probability of occurrence of wet periods: Wet periods are defined for the discussion here as periods where RF> PET. The probability of occurrence of 1 week, 2 consecutive weeks, and 3 consecutive wet weeks at Ratnapura and Bombuwela are given in figure 03. The probability of occurrence of wet periods is high at Ratnapura than at Bombuwela. At Bombuwela there is over 60% probability of having such wet weeks during both rainy periods. However, period of 2 and 3 consecutive wet weeks become shorter. The period from 20^{th} - 25^{th} week in Yala season and 45^{th} - 48^{th} weeks in Maha season seem to be critical at Bombuwela. When planning field crops, these periods could be avoided for crops which are very sensitive for wet conditions. For crops, which can tolerate excessive soil water conditions, surface drainage have to be improved by proper land preparation.

Probability of Occurrence of Dry Periods: Dry periods are also very important in crop production. They are needed for crop maturity. The dry weeks are defined as weeks having no rainfall for this discussion. Figure 04 shows the probability of one week, 2 consecutive weeks and 3 consecutive weeks being dry at Ratnapura and Bombuwela. The highest probability was shown during the 1^{st} dry period of the year. The highest probability of single week being dry is about 50% at Bombuwela. This is in 2^{nd} week of the year. The probability of 2 or 3 consecutive weeks being dry is very low at any time of the year at both stations. Crops which need 2-3 weeks of continuos dry period for maturity may not be suitable for this region.

CONCLUSIONS

The analysis show that areas represented by agro-climatic station at Ratnapura (WL1) have no limitations for growing rice in Yala and Maha season. The amount and distribution of rainfall is sufficient to meet the water requirement of the crop. In the areas represented by Bombuwela agro-climatic station (WL3 & WL4) length of rainy periods is not sufficient to meet the ET requirement by rainfall alone. Therefore, irrigation water has to be made available. Periods with sufficient length having ideal conditions for growing other field crops under rainfed conditions are not found in areas represented by both stations. However, in areas represented by Bombuwela, suitable periods could be identified with supplementary irrigation and improved drainage. Period from mid February to end of August can be considered for this purpose. Analysis of rainfall in many more stations are required before generalization could be made.

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