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WEEKLY ANALYSIS OF RAINFALL FOR AGRICULTURE PLANNING IN TIRUCHIRAPPALLI DISTRICT, TAMIL NADU USING GIS

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ABSTRACT

Most of the coarse grains like sorghum, pearl millet, finger millet and other millets are grown in dry lands only. Dry land Agriculture refers to growing of crops entirely under rainfed conditions. Based on the amount of rainfall received, dry land agriculture can be grouped into three categories:Dry Farming: Cultivation of crops in areas where rainfall is less than 750 mm per annum.Dry land Farming: Cultivation of crops in areas receiving rainfall above 750 mm.Rainfed Farming: Cultivation of crops in regions receiving more than 1, 150 mm. Tiruchchirappalli district, one of the three districts carved out of the composite district of the same name is located in the central part of Tamil Nadu between 10^{0} $18'$ and 11^{0} $25'$ north latitudes and 78^{0} 08' and 79^{0} 0' east longitudes the weekly rainfall data has been tabulated as monthly for the respective rain gauge stations. Probability analysis is a very useful tool for making important decisions in agricultural operation. In this study, Markov Chain Model has been extensively used to study spell distribution. The tabulated data are analyzed to calculate Probability Analysis Rainfall and Proabability (%) of Sowing weeks. the results are mapped in GIS environment by applying Spline interpolation.

Key words: Probability Analysis Rainfall, Conditional Rainfall, Probability of Wet weeks, Probability of sowing weeks

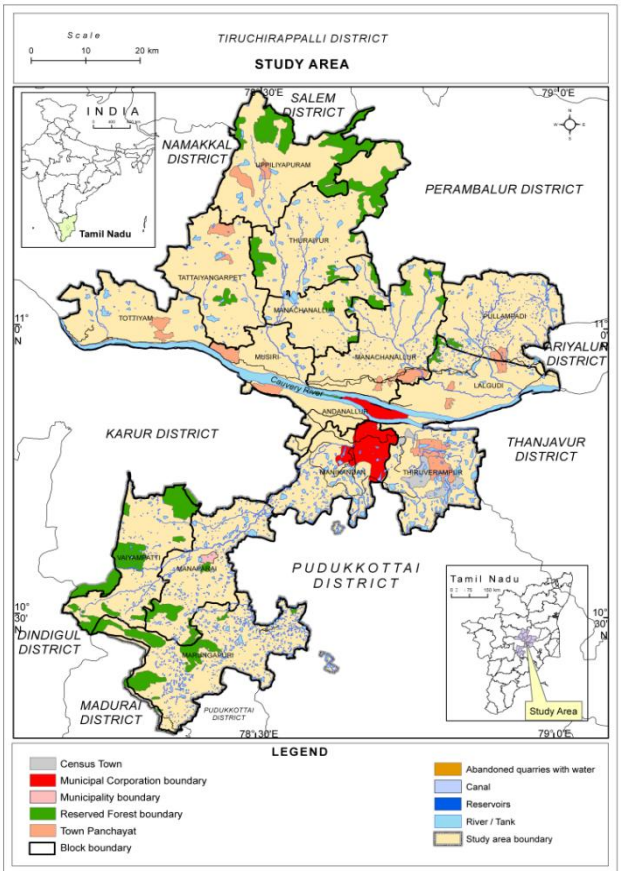
INTRODUCTION

Rainfed areas in India are highly diverse, ranging from resource rich areas with good agricultural potential to resource-constrained areas with much more restricted potential. Some resource rich areas (normally under temperate climate) are highly productive and already have experienced widespread adoption of modern technology. On the other hand traditional farming systems in drier and less favored areas is more of a survival mechanism rather than a growth oriented activity. Earlier, the rainfed farming systems, because of its risky nature was dependent upon locally available inputs (seeds, manures, animal draft) and used to grow a number of crops, which were able to withstand drought-like situation. But over time, the cropping systems have changed and presently farmers in these rainfed areas have limited options and have stated cultivating high value crops which require intensive use of costly inputs (chemical fertilizers/ pesticides, hybrid seeds, life saving irrigation, farm energy etc.) and find it difficult to manage the resources on their own.

STUDY AREA

Tiruchirappalli district is the geographical centre of Tamil Nadu and it is situated on the southern bank of river Cauvery which across and with an area of 4403.83 sq. km and lies between $10^{0}\ 18'$ and $11^{0}\ 25'$ north latitudes and 78^{0} 08' and 79^{0} 0' east longitudes is situated on the plains between the Shevaroy Hills to the north and the Palani Hills to the south and south-west. The city acts as an important trade centre for the surrounding districts and one of the 32 constituent administrative districts of the Tamil Nadu State. This district consists of 9 Taluks, namely Lalgudi, Manachanallur, Manapparai, Musiri, Srirangam, Thuraiyur, Thottiyam, Tiruverumbur and Tiruchirappalli. The land immediately surrounding the Kaveri is made up of fertile alluvial soil deposited by the Kaveri and its tributary, the Kollidam. Further south, the surface is covered by poor-quality black soil. The alluvial soil is conducible for agriculture and crops such as ragi (finger millet) and cholam (maize) are cultivated. North-east of Tiruchirappalli runs a belt of cretaceous rock known as the "Trichinopoly Group". Layers of archaean rocks, granite and gneiss covered by a thin bed of conglomeratic laterite are found to the south-east of the city. The district enjoys a tropical climate and it is hot and dry for at least eight months of the year. The hottest months are from March to July during which the city experiences frequent dust storms. During this period, the days are extremely warm and dry while evenings are rendered cooler due to the cold winds that blow from the south-east. Tiruchirappalli experiences a moderate climate from August to October, tempered by heavy rain and thundershowers, and cool and balmy climate from November to February.

Fog and dew are rare and occur only during the winter season. The normal annual rainfall over the district varies from about 730 mm to about 900 mm. It is the minimum around Musiri (732 mm) in the western part.



METHODOLOGY

There are thirteen rainfall stations selected for the present study .The weekly rainfall data for the period of 1980-2012 have been collected for major stations and available rainfall stations which are installed in last five years .the weekly rainfall data has been tabulated as monthly for the respective rain gauge stations. The tabulated data are analyzed to calculate Probability Analysis Rainfall and Proabability (%) of Sowing weeks. the results are mapped in GIS environment by applying Spline interpolation. With the following notations, the initial and conditional probabilities for the above said threshold limits have been computed using the following formula. Under initial probabilities, the probability of a given week as wet or dry is estimated, whereas in the case of conditional probabilities, if a given week 'i' is wet, then the chances of (i+k)th period as wet, wet/wet or dry/dry are estimated. A period is said to be wet when the parameter of that period exceeds a threshold limit and to be dry when under the limit. P (W) = F (W)/n P (W/W) = F (W/W)/F(W) P(W) – Probabilities of the week being wet P(W/W) – Conditional probability of wet week preceded by a wet week n= number of

years of data F(W) – Frequency of wet weeks F(W/W) – Frequency of wet weeks preceded by another wet week.

PROBABILITY ANALYSIS RAINFALL

Climatic descriptions based on averages might be suitable for stations where the climate for each of the individual years follows the average climatic pattern. However, this generalization is not often true because of uncertainties inherent in rainfall patterns. The presentation of rainfall data in the form of simple arithmetic averages therefore provides a very general understanding for a generalized application. Many agricultural operations revolve around the probability of receiving given amounts of rainfall. Markov chain probability is one of the models that have been found suitable to describe the probability daily and weekly rainfall distribution. In the first order Markov chain, the probability of an event that would occur on any single day depends only on the conditions during the preceding day and is independent of events of further preceding days. The model calculates the initial probabilities of getting a dry spell / wet spell in a given standard meteorological week. The calculation of conditional probabilities provides the information on the dry spell followed by dry spell or wet spell vice versa. The probabilities of rainfall can be used for a number of agricultural planning purposes such as land-use planning, choice of crops, cropping system and assessing level of risk spatially. Hence, the mapping rainfall probability characteristics could greatly help the transfer of farming systems technology to the field, which forms the basis for the present study. In the present chapter, the daily rainfall data for the 28 years (1980 –2007) have been collected for 18 stations of in and around the study area and converted into weekly totals as meteorological standard weeks.

CONDITIONAL RAINFALL

Conditional rainfall can be conceived as a particular amount of rainfall anticipated in a particular place over specified period normally a week. It is very useful for predicting rainfall for sowing purpose. If the probability level is greater than 66 %, advance sowing in a dry soil can be taken (Practical Manual of Agronomy, 1996 - Tamil Nadu). Indian Meteorological Department divides a year into 52 weeks and each such week of 7 or 8 days called Standard Meteorological Week (SMW). As per the norms followed by the Indian Meteorological

Department (IMD), a day is considered as a rainy day if it gets rainfall of 2.5 mm or more. A week with 7.5 mm or more rainfall as a wet week and a week with less than 7.5 mm as a dry week, if consecutive week record 7.5 mm or more, it is considered as a wet spell, more over three week total rainfall exceeding 25 mm could be considered as an important factor in agricultural operations mainly for sowing (Nagarathinam, 1990, Ramanan, 2006, banukumar 2012). Hence, a sowing week is considered as a sowing week only if it has a weekly rain of 7.5 and the initial three weeks total exceeded 25 mm.

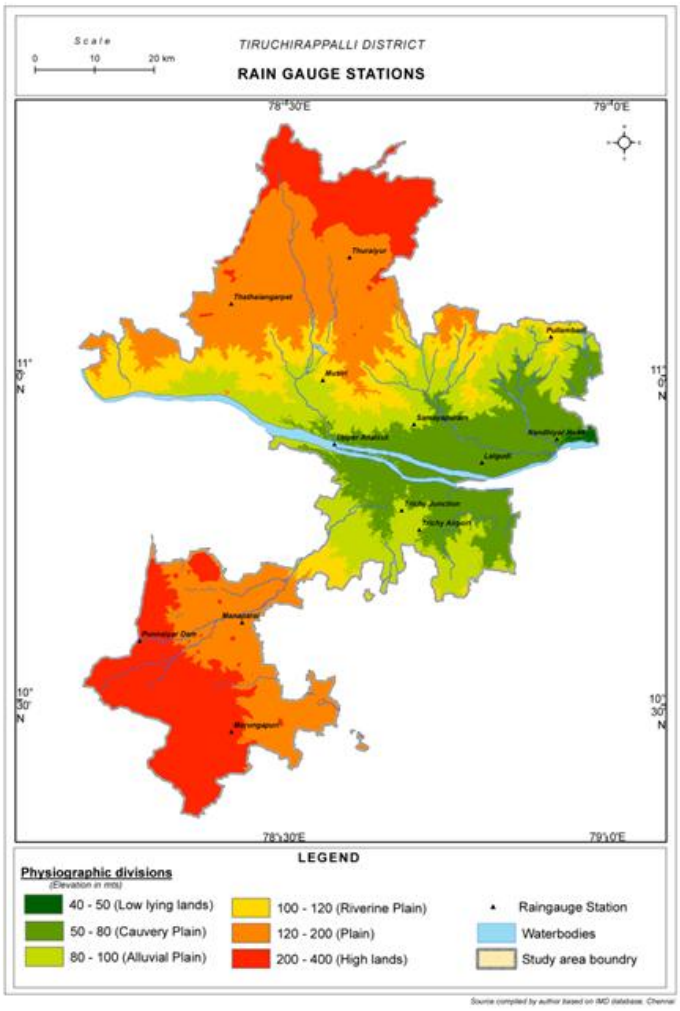


TABLE: 1. PROBABILITY ANALYSIS OF RAINFALL

Smw	*Month*	Golden Rock	Grand Anaicut	Illipur	Keeranur	Kulithalai	Lalgudi	Manaparai	Marungapuri	Mayanur	Musiri	Nandhiar Head	Pullambadi	Thammampatti	Thuraiyur	Trichy Junction	Trichy Town	Thirukkattupalli	Upper Anaicut
1	*Jan*	19	14	9	13	15	14	14	11	14	10	20	15	6	14	14	15	9	0
2	*Jan*	29	18	23	22	23	23	14	11	14	10	25	15	19	9	24	20	14	15
3	*Jan*	10	9	9	13	15	10	14	17	7	10	15	15	0	9	5	10	14	10
4	*Jan*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	*Jan*	14	13	4	13	0	5	14	0	0	5	5	5	6	4	9	5	13	5
6	*Feb*	11	15	10	11	17	10	17	10	14	11	5	10	0	11	10	11	19	10
7	*Feb*	5	10	10	5	17	5	5	10	7	11	5	10	0	5	5	5	10	5
8	*Feb*	6	0	5	5	0	5	0	0	8	0	11	0	13	5	0	5	0	5
9	*Feb*	0	0	14	10	7	0	18	10	0	0	5	15	6	14	0	0	14	0
10	*Mar*	12	18	12	18	25	24	16	18	23	24	24	19	7	11	12	11	24	12
11	*Mar*	12	18	12	6	0	6	11	6	8	18	12	13	29	28	6	5	12	6
12	*Mar*	0	6	6	0	9	0	17	0	0	6	0	0	0	18	0	0	0	6

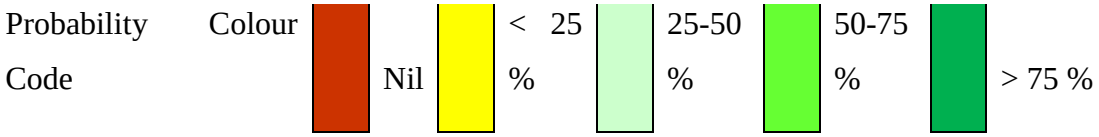
13	***Mar***	0	4	0	4	0	0	0	0	5	0	4	0	11	0	0	0	0	0
14	***Apr***	24	21	22	8	11	18	15	10	17	22	18	18	29	17	24	22	17	33
15	***Apr***	16	21	13	21	22	23	19	24	22	17	18	23	12	38	20	19	21	25
16	***Apr***	28	25	17	25	16	23	38	29	21	30	14	23	33	42	28	22	25	25
17	***Apr***	20	17	26	33	37	14	28	35	37	30	14	9	28	25	24	22	21	25
18	***Apr***	29	39	43	33	36	46	36	29	39	29	32	29	50	41	29	26	32	32
19	*May*	52	41	37	23	41	33	31	23	57	41	26	30	45	42	44	46	33	33
20	*May*	44	41	48	38	41	30	58	30	39	41	30	37	55	46	52	50	26	44
21	*May*	40	48	33	46	50	52	54	30	57	44	44	59	45	46	48	50	41	37
22	*May*	32	44	41	44	39	41	56	32	39	36	33	44	50	37	33	42	41	44
23	***Jun***	32	25	46	38	35	36	46	45	44	32	30	27	45	33	39	30	20	25
24	***Jun***	32	33	46	35	24	23	42	32	11	23	30	23	50	33	26	30	36	33
25	***Jun***	16	13	15	19	13	14	13	9	6	5	5	14	0	8	13	17	16	17
26	***Jun***	19	11	11	14	5	7	7	23	5	8	7	12	23	11	11	7	7	0
27	***Jul***	30	21	21	39	30	19	27	27	21	17	23	19	29	25	35	33	30	20
28	***Jul***	33	25	39	36	10	26	38	27	16	26	31	31	33	21	27	26	22	32

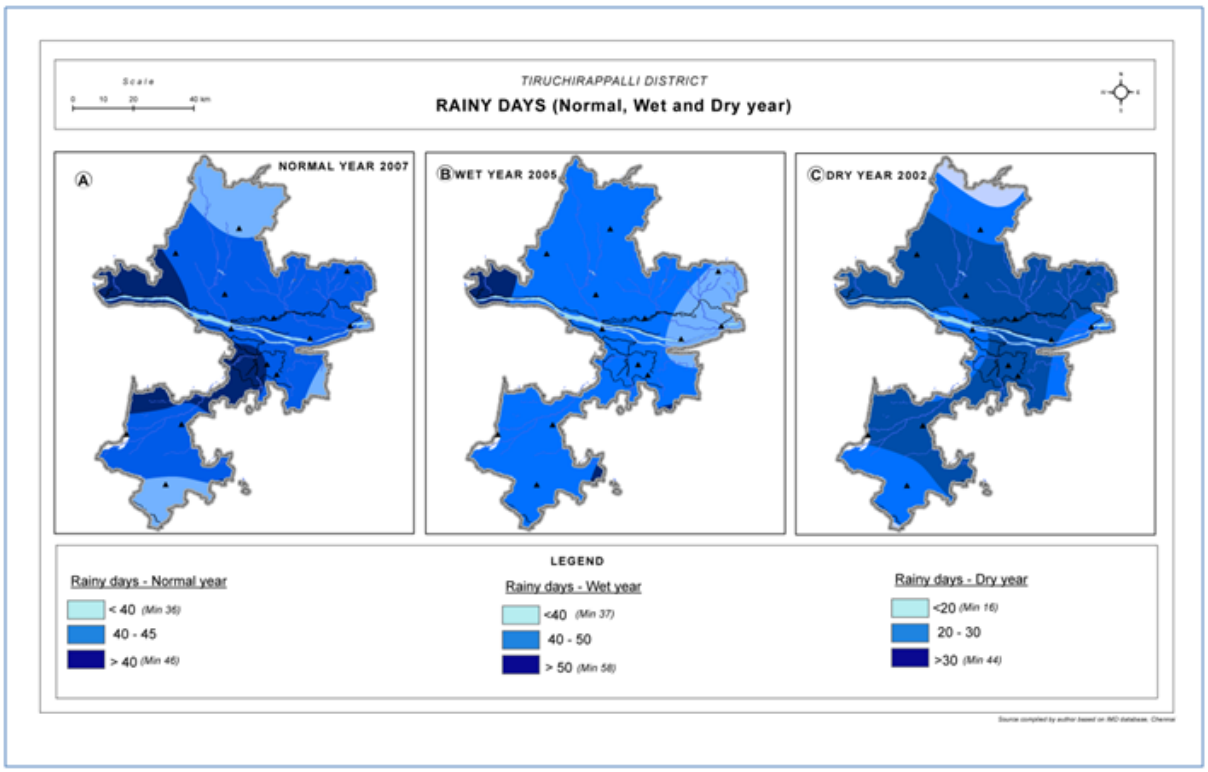
29	***Jul***	37	32	36	39	25	33	35	31	25	26	26	31	23	36	35	33	22	28
30	***Jul***	37	36	36	36	30	26	31	12	35	26	33	23	32	29	35	30	33	32
31	***Jul***	32	36	43	29	27	33	32	29	29	30	22	30	32	39	39	37	39	32
32	***Aug***	25	36	36	39	23	33	25	25	33	22	33	30	30	30	32	30	29	21
33	***Aug***	29	29	39	29	18	26	36	25	32	26	26	33	45	37	36	30	25	32
34	***Aug***	46	54	57	57	32	44	46	29	42	30	44	44	38	44	43	44	46	43

35	***Aug***	74	71	57	68	57	81	70	62	64	71	71	74	70	79	79	78	75	68
36	***Sep***	56	54	46	54	43	44	52	35	50	50	43	41	50	57	46	56	50	50
37	***Sep***	81		54	54	48	70	67	50	64	57	54	59	59	71	71	70	61	57
38	***Sep***	48	46	61	68	62	63	70	42	73	57	54	56	55	68	46	44	61	50
39	***Sep***	67	75	57	64	81	89	81	54	68	79	68	85	73	75	86	81	79	75
40	***Oct***	75	71	81	79	73	68	75	64	68	64	64	67	70	75	71	73	68	68
41	***Oct***	64	64	58	68	73	64	82	61	68	75	61	48	70	79	75	77	61	64
42	***Oct***	64	75	69	68	64	79	82	57	59	79	75	78	52	79	61	54	68	64
43	***Oct***	71	86	65	79	68	79	68	54	91	75	71	70	78	71	75	77	75	64
44	***Oct***	79	75	68	75	64	86	68	54	73	75	82	79	61	64	79	81	79	68
45	***Nov***	71	82	64	75	82	86	75	57	77	75	71	71	74	75	63	74	71	68
46	***Nov***	46	43	39	43	50	43	54	39	55	54	50	50	48	54	41	44	54	36
47	***Nov***	43	46	50	39	45	46	50	36	41	50	43	43	52	46	52	52	43	50
48	***Nov***	46	46	25	46	41	50	50	14	23	39	46	39	22	21	48	44	46	29
49	***Dec***	61	52	54	61	59	50	54	54	43	43	57	61	43	41	56	54	56	37
50	***Dec***	36	44	32	36	27	36	39	35	19	29	29	39	38	26	44	41	37	37
51	***Dec***	32	41	43	43	41	39	43	38	38	32	39	39	33	37	37	38	41	33
52	***Dec***	29	33	29	18	32	29	25	19	29	21	36	25	25	19	30	31	30	19
Freq.at %P.	<25	18	22	20	20	23	21	19	23	24	21	21	23	18	20	18	19	23	22

Freq.at75% or nil P.	3	5	1	4	2	6	5	0	2	6	2	3	1	6	5	5	4	1
Freq.at50%P.	11	12	13	13	11	12	15	10	12	13	12	11	12	12	11	12	13	12

Source: Compiled by Author





PROBABILITY OF WET WEEKS

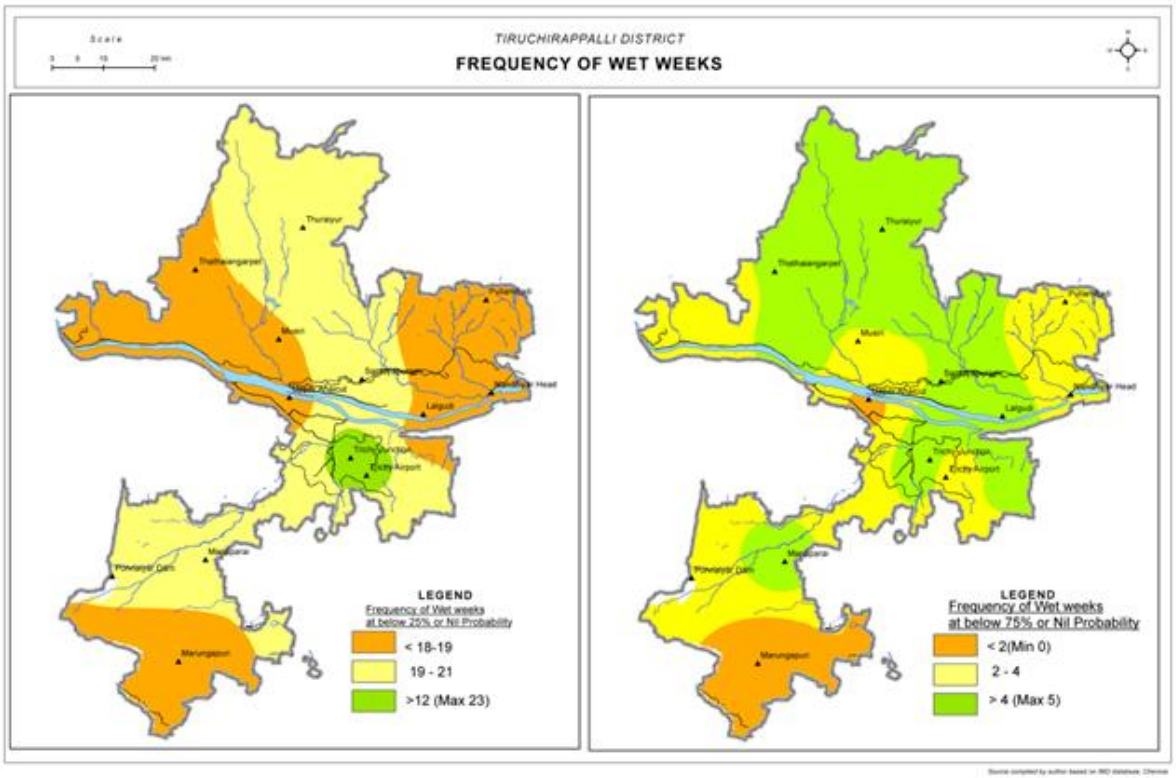
The annul pattern of wet week occurrences at different probability level (<25 % 25-50 % 50 -75 % and >75 %) for the entire district using colour code is shown in Table 3.9. The probability of wet week occurrences less than 25 % is observed between the 1st and 15th week covering January, February, March and first two weeks of April. From the mid April to mid June the probability gradually increases and varies between 25 % and 50 % due to the convectional rainfall during these months. Before the commencement of southwest monsoon, again the wet week probability becomes poor during the last two weeks of June. By the arrival of monsoon wind over central and eastern Tamil Nadu, from July 1st week onwards the probability of wet week is progressive and attains its maximum of 50 percentage.

With the established monsoon, from the 35th week (last week of August), the probability of wet week exceeds 50 % and exceeds even 75 % during the month of October. The quantum variation of wet week frequency is portrayed spatially in Figure 3.11 with the probability of less than 25 % or nil. The frequency of wet week is higher (above 21weeks) over western parts of the district covering Thottiyam, Thataiyangarpet, Musiri blocks and eastern part of the district covering Pullambadi and Lalgudi blocks. Marungapuri block, which is southern part of the district, also

comes under the poor probability of wet weeks. The wet weeks with poor probability is less in number (18 or 19) over rest of the blocks covering central tract of the district. On the other hand, the pattern of wet week occurrences at 75 % of probability level is similar to spatial occurrences of wet weeks with poor probability as shown in Figure 3.12. If considering the frequency of wet week occurrences above 50 % of probability, it varies between 10 to 12 over the major portion of district and it becomes higher (above 12) over Thottiyam, Thattaiyangrpet, Manaparai and Vayiyampatti which are the places also under higher frequency of weeks with poor probability implies the impact of monsoon wind over these provinces shown in figure 3.13.

PROBABILITY OF SOWING WEEKS

If consecutive weeks record 7.5 mm or more, it is considered as a wet spell, more over three week total rainfall exceeding 25 mm could be considered as an important factor in agricultural operations mainly for sowing. Hence, a sowing week is considered as a sowing week only if it has a weekly rain of 7.5 and the initial three weeks total exceeded 25 mm. Raj (1998) in his diagnostic study of Northeast monsoon rainfall found that the normal date of cessation of rains as 27th December (52nd week of December), so any sowing week falling beyond 37th standard week would lead a stress for short term crops like 100 days crops, beyond the rainy period, however the vegetables grown in less than 100 days be considered during sowing week analysis. Table 3.10 summarizes the probability of sowing weeks over Tiruchirappalli District.


TIRUCHIRAPPALLI DISTRICT
FREQUENCY OF WET WEEKS
LEGEND
Frequency of Wet weeks
at below 25% or Nil Probability
< 18-19
19 - 21
>12 (Max 23)
LEGEND
Frequency of Wet weeks
at below 75% or Nil Probability
< 2(Min 0)
2 - 4
> 4 (Max 5)

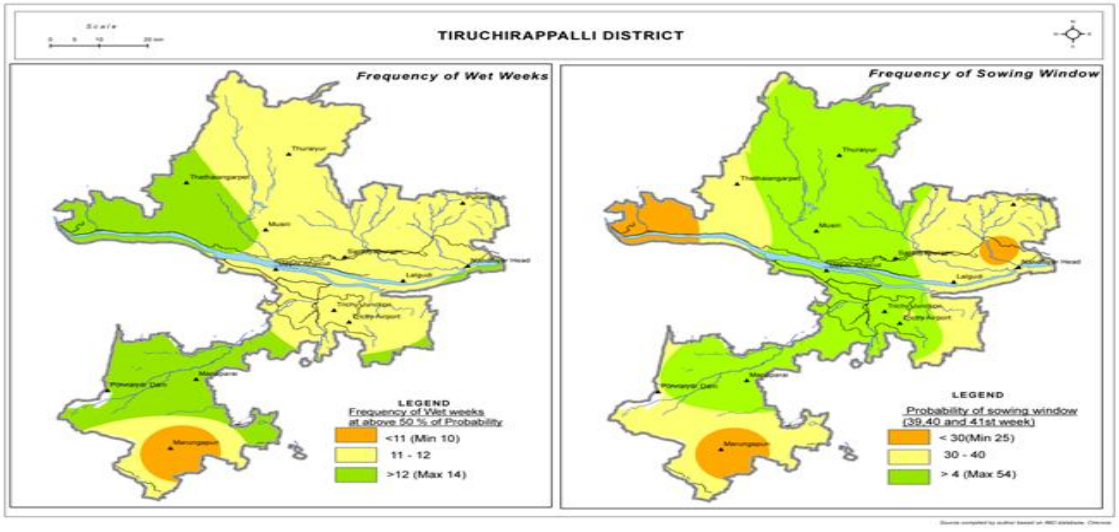

TIRUCHIRAPPALLI DISTRICT
Frequency of Wet Weeks
LEGEND
Frequency of Wet weeks
at above 50 % of Probability
<11 (Min 10)
11 - 12
>12 (Max 14)
Frequency of Sowing Window
LEGEND
Probability of sowing window
(39,40 and 41st week)
< 30(Min 25)
30 - 40
> 4 (Max 54)

TABLE .2. PROABABILITY (%) OF SOWING WEEKS

SI. No	Station / smw	34, 35, 36	35, 36, 37	36, 37, 38	37, 38, 39	38, 39, 40	39, 40, 41	40, 41, 42	41, 42, 43	42, 43, 44	43, 44, 45	44, 45, 46	45, 46, 47	Freq of S.weeks	Average P.
1	Golden Rock		32		25	29	39	43	29	43	46	32		9	35
2	Grand Anaicut					32	36	39	43	54	61			6	44
3	Illipur	29	25			29	32	36	29	39	32			8	31
4	Keeranur				25	36	36	32	32	54	50	29		8	37
5	Kulithalai					35	43	35	35	35	35	26		7	35
6	Lalgudi				39	39	32	39	46	57	64	39		8	45
7	Manaparai		25		39	50	54	54	50	54	43	29		9	44
8	Marungapuri		25		25		25	29	29	29	25			7	27
9	Mayanur					30			30	43	48	26		5	36
10	Musiri				32	32	39	32	46	54	43	29	25	9	37
11	Nandhiar Head					36	36	36	36	50	43	29		7	38
12	Pullambadi				29	32	25	25	32	50	46	32		8	34
13	Thammam patti		25			38	42	29	33	33	42	33		8	34
14	Thuraiyur		29	25	32	46	50	43	39	43	39	25		10	37
15	Trichy Junction				29	32	54	32	29	46	43			7	38
16	Trichy Town		30		30	33	52	26	26	37	44	26		9	34

17 18	Thirukkattupalli	25	29	25	36	36	36	36	32	43	50	32		11	34
	Upper Anaicut		25			36	43	32		36	36			6	35
Average P.		***27***	***27***	***25***	***31***	***35***	***40***	***35***	***35***	***44***	***44***	***30***	***25***	8	36

Source: Compiled by Author

It is clear from the table, that no where the probability of showing week exceeds 64 percentage except over Lalgudi during the sowing window comprising 44, 45 and 46th weeks. Hence, it is presumed that the rainfed and dry cropping activity of the district always relay with supplementary irrigation mainly groundwater. By considering the entire district, sowing window comprising the weeks of 39, 40 and 41 (4th week of September and 1st and 2nd week of October) has the average probability of 40 % which is not only the highest but also the earliest sowing window. Figure 3.14 reveals the spatial variation of sowing window probability over the district. The probability of sowing window is higher (40-50 %) over the blocks covering central tract stretching north - south of the district. whereas the rest of the blocks found over east and western parts of the district, the probability found to be less than 40 per cent.

CONCLUSION

Probability analysis of sowing weeks shows that no where the probability of showing week exceeds 64 percentage except over Lalgudi during the sowing window comprising 44, 45 and 46th weeks. Sowing window comprising the weeks of 39, 40 and 41 (4th week of September and 1st and 2nd week of October) has the average probability of 40 % which is not only the highest but also the earliest sowing window. Hence, it is presumed that the rainfed and dry cropping activity of the district always relay with supplementary irrigation mainly groundwater.

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