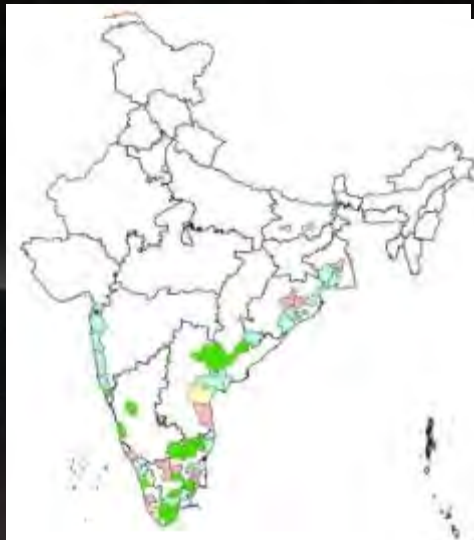


Identifying suitable areas for hybrid rice seed production



Sailaja Banda, SR Voleti, AS Hariprasad, LV Subbarao and
BC Viraktamath

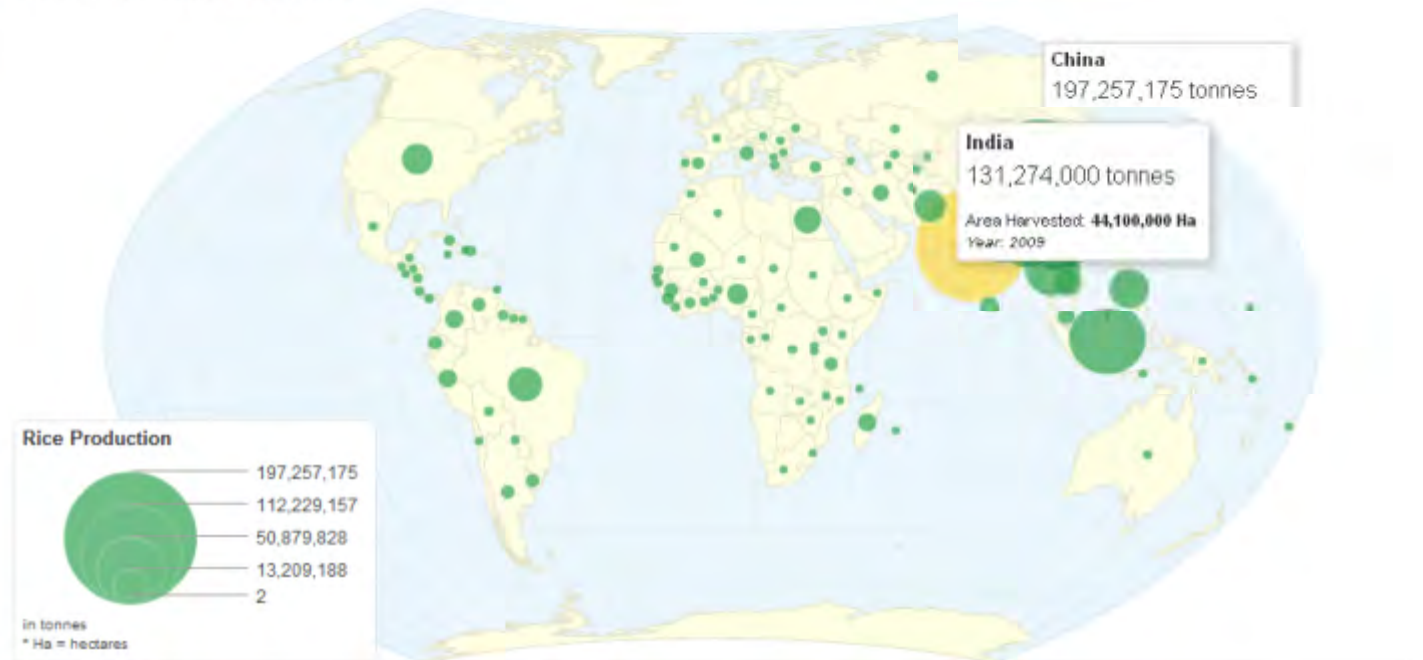
Directorate of Rice Research
Rajendranagar
Hyderabad

Email: saila_r@yahoo.com



Importance of rice crop

Worldwide Rice Production



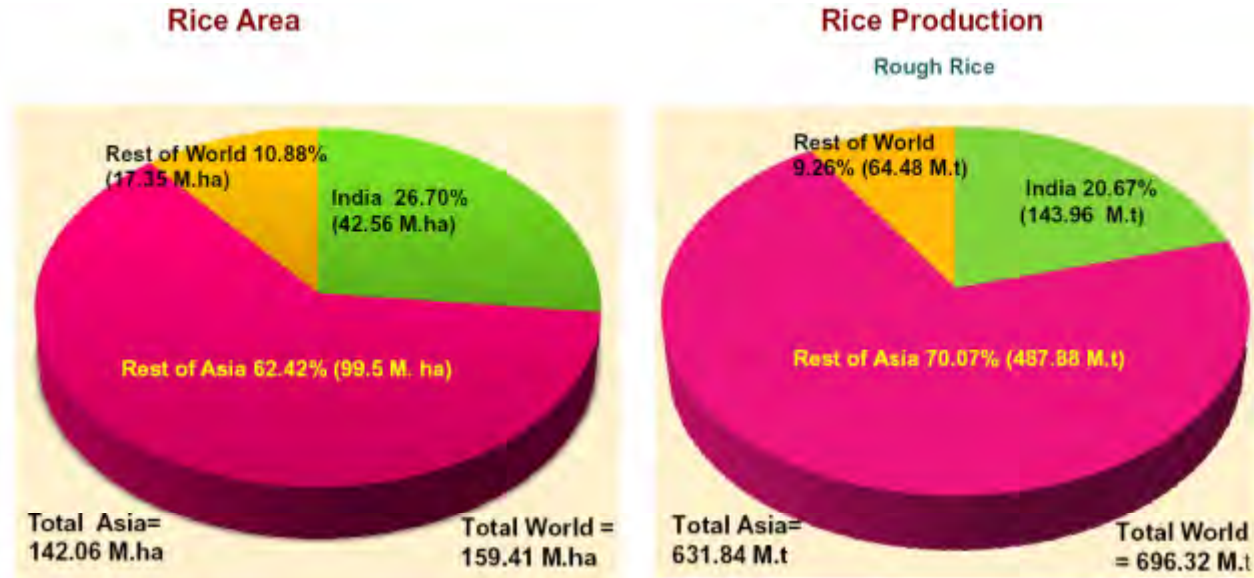
<http://chartsbin.com/view/1009>

Rice is the most important food crop in developing countries and plays a key role in delivering global food security



Importance of rice crop

Asia accounts for 89 per cent and 91 per cent of world's rice area and production respectively.



Among the rice growing countries in the world, India has the largest area under rice crop (about 42.56 m. ha) and ranks second in production

India accounted for 20.67% total rice production of world during 2010



Gap

Increase population- increase in production- existing resources and other inputs without adversely affecting the quality of environment

Among the available and immediately adoptable technologies, hybrid rice technology is one which is likely to play a very pivotal role in achievement of the targeted production increase.

Hybrid Rice is one of the proven technologies to enhance rice production and productivity



Hybrid rice seed production

- Success of hybrid rice depends primarily on the availability of heterotic hybrids efficient and economic **hybrid seed production** effective technology transfer efforts
- The main objective in **hybrid rice seed production** is to get maximum seed set on female lines so that the **seed yields** are higher
- The **seed yields** depend on various factors **season ,location** parental lines involved, row ratio, extent of synchronization, supplementary pollination etc.

Study was aimed to identify different locations in India where seasonal weather conditions are favourable to hybrid rice seed production



Objectives

- To study the climatic conditions in different locations where hybrid rice has already grown
- To identify other locations where the above conditions are prevailing



Ideal seasonal conditions during flowering

- Ideal seasonal conditions during flowering for higher seed set are

Daily mean temperature of 25-30°C

Relative Humidity 70-80%

Difference in day and night temperature 8-10°C,
preferably 5-7°C

Sufficient sunshine and moderate wind velocity of
2-3 m/second.

No continuous rainy spell for 2-3 days during
peak flowering time



Seasons – flowering

In India *rabi* (*dry*) season (**November – April**) has been found to be better than the *kharif* (*wet*) season (**June-October**) for hybrid seed production

Flowering occurs

Rabi season - February and March months

Kharif season- August and September months



Methodology

In Dry season - **Karimnagar** and **Warangal** districts of Andhra Pradesh State is most ideal for hybrid rice seed production

- Day wise weather parameters of Warangal district for **February and March** months were collected from AICRIP data sets for the years 1990-2005 and used for identifying alternate locations suitable for hybrid seed production
- **Karimnagar, Coimbotore, Mandya, Kolhapur** and some other districts were examined with 2008 and 2009 weather data for confirmation



Methodology

- A software program was developed to calculate hourly temperatures by using the equation 1 (Bouman *et al.*, 2001)

$$\text{Hourly temperature (Td)} = (\text{Tmin} + \text{Tmax}) / 2 + (\text{Tmax} - \text{Tmin}) * \cos(0.2618 * (\text{h} - 14)) / 2 \quad (1)$$

Tmin, Tmax - minimum and maximum temperatures ; h - time of day

- These temperatures averaged on 12 hour basis and differences in day and night temperatures were computed

```
Private Sub Command0_Click()  
Dim main1 As Recordset  
  
Dim mydb As Database  
' Dim stDocName, loc As String, colcnt, cnt, rowcnt, xcoord, i, j, M, k, l, cntsix, cntfive As Integer  
Dim htemp(24) As Single, i, j As Integer  
  
'strmain = "select * from main where [tr_no] = " & Forms![main2]![tr_no] & " "  
Set mydb = CurrentDb  
Set main1 = mydb.OpenRecordset("imdweek")  
  
'("select * from modifiedtemperatures where year[time]=" & Forms![form1]![r_year] & "")  
  
main1.MoveFirst  
Do While Not main1.EOF()  
j = 6  
For i = 1 To 24  
htemp(i) = ((main1!i_avgmaxt + main1!i_avgmint) / 2) + (main1!i_avgmaxt - main1!i_avgmint) * Cos(0.2618 * (j - 14)) / 2  
If j = 24 Then
```

Bouman, B.A.M., Kropff, M.J., Tuong, T.P., Wopereis, M.C.S., ten Berge, H.F.M and van Laar, H.H. 2001. *ORYZA 2000: Modeling lowland rice*. Int. Rice Res. Inst., Philippines and Wageningen Agric.Univ., the Netherlands. pp. 235



Methodology

Weekly weather data of Warangal district – averaged for 15 years

Month	Week	Rh1 (%)	Rh2 (%)	Rh (%)	Mean Temp °C	Difference in day and night temperatures °C	Rainfall (mm)
2	1	84.50	49.72	67.11	25.43	9.98	2.20
2	2	81.86	41.30	61.58	26.07	9.84	0.56
2	3	79.27	40.00	59.64	26.77	10.42	0.74
2	4	75.10	40.33	57.71	29.06	9.72	0.00
3	1	75.73	42.01	58.87	30.59	9.77	0.00
3	2	76.86	39.43	58.15	29.25	10.23	0.10
3	3	75.83	35.55	55.69	28.65	10.90	0.19
3	4	78.02	39.26	58.64	30.46	10.77	0.36



Methodology

Mean temperatures of 4 weeks of February and March are in the range of 25-30°C and difference in day and night temperatures are in the range of 9-10°C

Rainfall is within the range of 0 - 2.2 mm for these 8 weeks

Relative humidity (average of RH1 and RH2) is in the range of 55 – 67%

RH1 is within the range of 70-80% confirming with the requirement of favourable RH for hybrid seed production



Methodology

Grid wise weather data on maximum, minimum and mean temperatures, rainfall were collected from IMD for the years 1995-2005.

Year wise individual text files were supplied for each parameter.

Daily normal data of IMD was used for RH and Wind Speed.



Methodology

A software program was developed to convert these individual text files into one single database

Climate data interface

Enter the path of IMD files: Select weather parameter:

Starting Year: Ending Year:

- Max. temp
- Min. temp
- Mean Temp
- RH1
- RH2
- Rainfall
- Windspeed

Field1	i_lat	i_long	i_month	i_week	Max temp	Min temp
1	8.5	76.5	2	1	31.17	21.86
1	8.5	76.5	2	2	31.64	21.78
1	8.5	76.5	2	3	31.86	22.21
1	8.5	76.5	2	4	32.09	22.23
1	8.5	76.5	3	1	32.29	22.32
1	8.5	76.5	3	2	32.65	23.00
1	8.5	76.5	3	3	32.84	23.39
1	8.5	76.5	3	4	33.05	23.92



Methodology

There were totally 346 total grid points for temperature and 960 points for rainfall.

These files were converted to geo database files using Arc catalog and thessien polygons were generated for each point using spatial interpolation method of ArcGIS package.

This map was overlaid with district level digital database of India (Survey of India, 2010)

District wise data on maximum, minimum, mean temperatures and difference in day and night temperatures were computed across polygons



Methodology

Due to non availability of grid wise data for other parameters like relative humidity and wind speed daily normal data was downloaded from the IMD website.

This data was joined with digital data of India at district level

Maps were generated for each week in the respective months for mean temperature, difference in day and night temperature, relative humidity and rainfall.

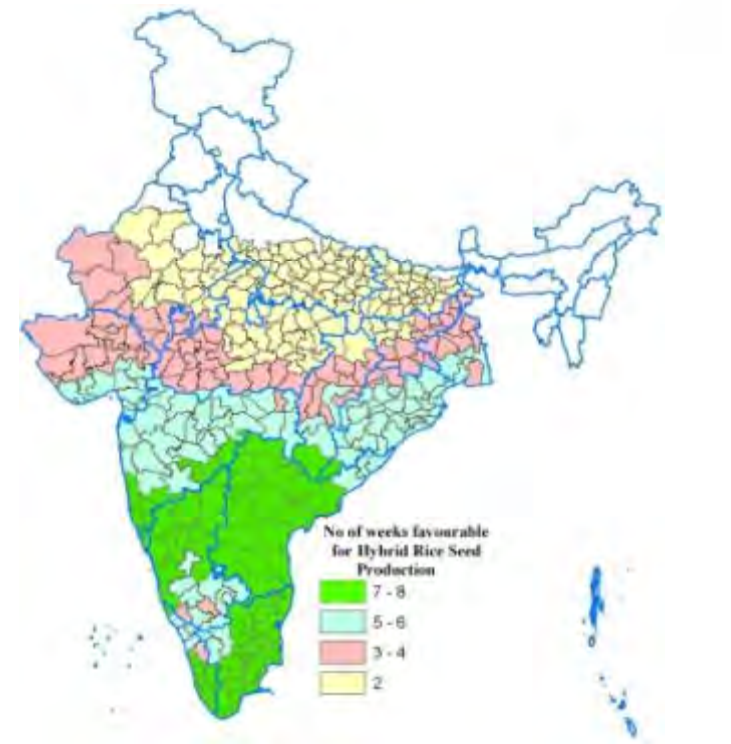
This digital data was queried further for above favorable weather conditions.



Results-temperature(*Rabi*)

Districts were filtered for favourable mean temperature (25-30 °C) and difference between day and night temperatures (5-10 °C)

All the districts from southern states of **Andhra Pradesh, Tamilnadu, Karnataka, Kerala** and few districts from **Goa, Orissa, Chhattisgarh, Gujarat and Maharashtra** are matching with above criteria for temperature continuously for 7 & 8 weeks during flowering time (February and March) of *rabi* season

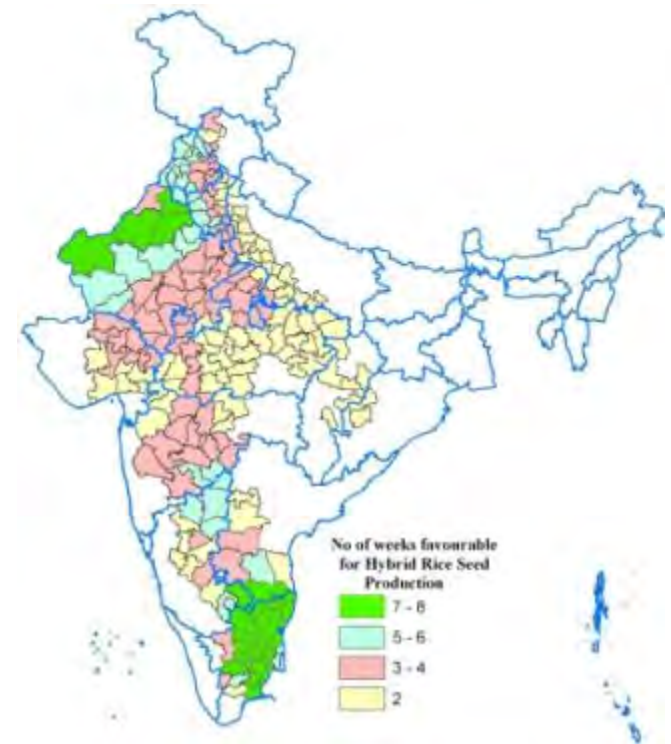


Results-temperature(*kharif*)

Mean temperature -(25-30 °C)

Difference between day and night temperatures
-(5-10 °C)

Chittoor district from Andhra Pradesh, Kolar from Karnataka, Bikaner, Churu, Hanumangarh, Jaisalmer districts from Rajasthan, all districts from Tamilnadu are matching with favourable temperatures for 7&8 weeks.



Further these districts were filtered for rainfall suitable for hybrid seed production.



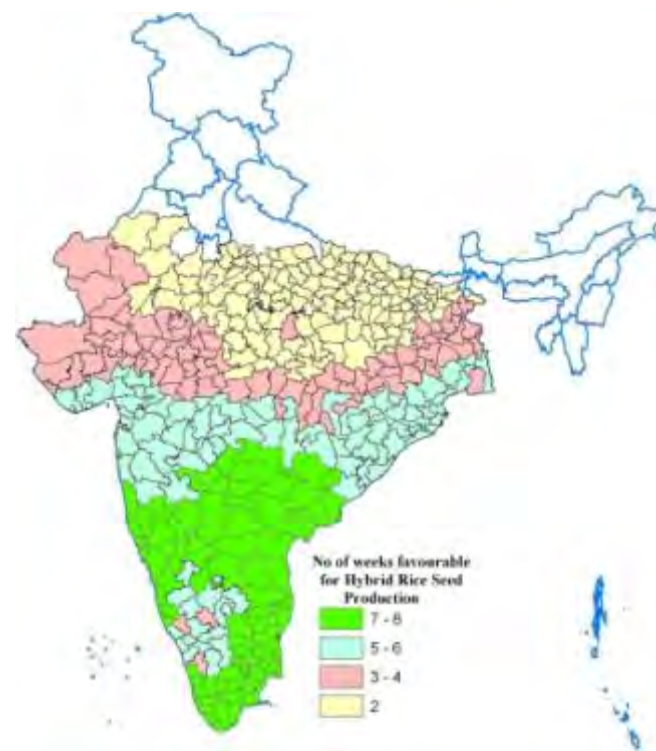
Results-temperature and rainfall (*rabi*)

Mean temperature -25-30°C

Difference between day and night
temperatures -(5-10 °C)

Rainfall -0-3 mm and 0-10 mm

All the districts matching for favourable temperature are also meeting the rainfall requirement (0-3 mm) for hybrid seed production during flowering period for 7 & 8 weeks in the rabi season



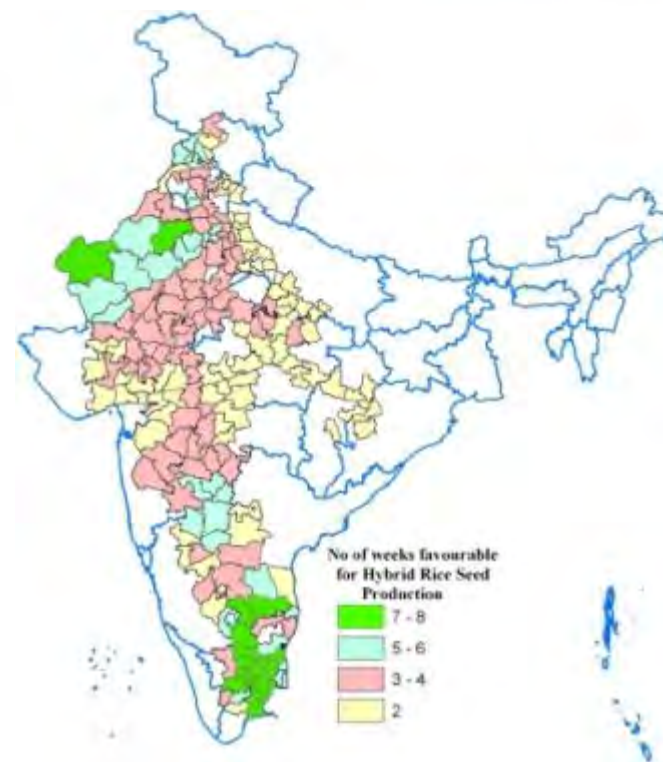
Results-temperature and rainfall (*kharif*)

Mean temperature -25-30°C

Difference between day and night
temperatures -(5-10 °C)

Rainfall -0-3 mm

There are Chittoor district from Andhra Pradesh, Kolar from Karnataka, Churu, Jaisalmer districts from Rajasthan, most of the districts from Tamilnadu are matching with favourable temperature and rainfall (0-3 mm) for 7&8 weeks



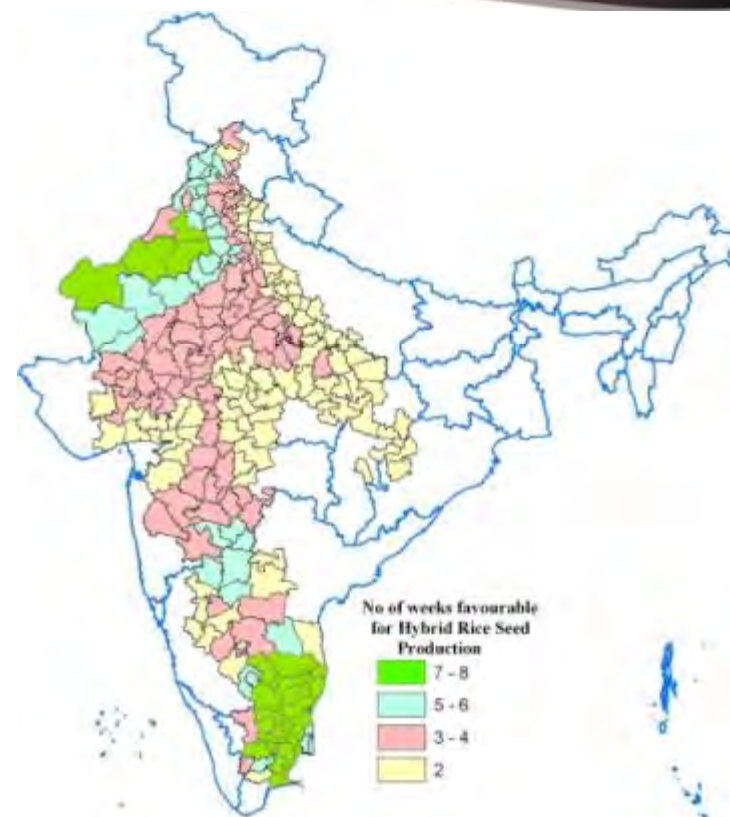
Results-temperature and rainfall (*kharif*)

Mean temperature -25-30°C

Difference between day and night temperatures -(5-10 °C)

Rainfall -0-10 mm

All the districts matching for favourable temperature are also meeting the rainfall requirement (0 and 0-10 mm) for hybrid seed production during flowering period for 7 & 8 weeks in the rabi season



Results-temperature, rainfall, relative humidity and wind speed (*rabi*)

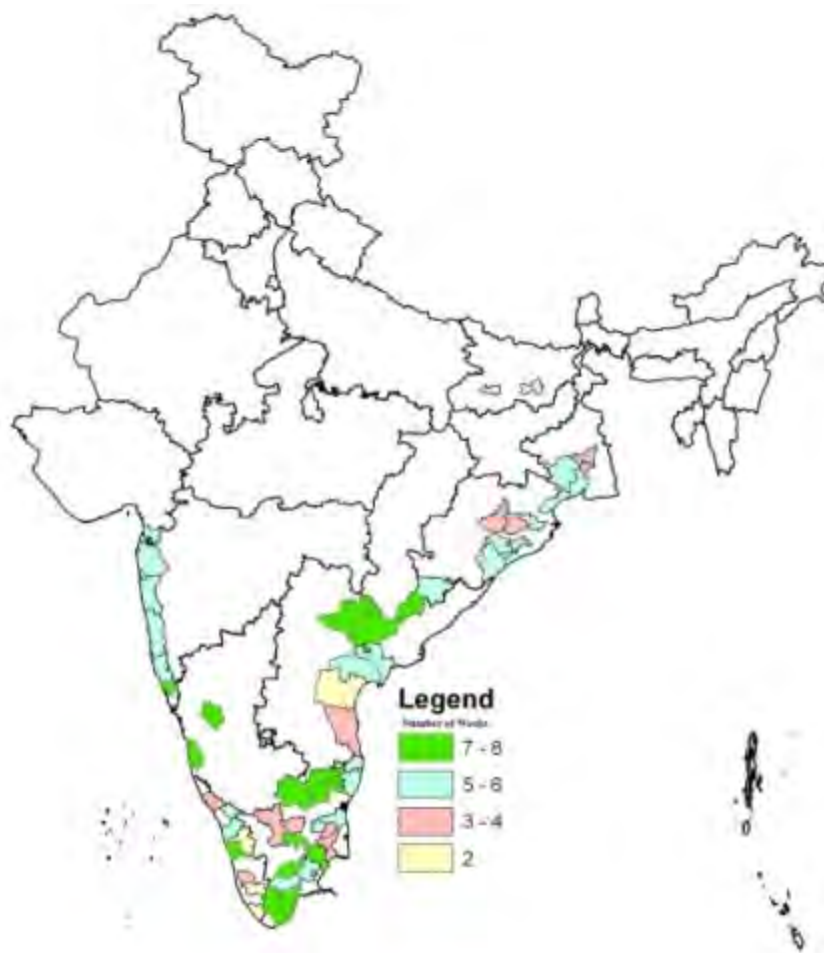
Mean temperature -25-30°C; Difference between day and night temperatures -(5-10°C);
Rainfall -0-3 mm and 0-10 mm; Relative Humidity -55-70%; Wind Speed - 0-3 m/s

No. of favourable weeks	States(Districts)
7-8	Andhra Pradesh - Khammam Goa - North Goa Karnatka – Haveri, Udupi Kerala - Trishshur Orissa - Malkangiri Tamilnadu – Dharmapuri, Madurai, Tiruvannamalai, Vellore, Karur, Pudukkottai, Tirunelveli, Tuticorin (Tuttukudi)
5-6	Andhra pradesh – Guntur, Krishna Gujarat - Valsad Kerala – Malappuram, Wayanad Maharashtra- Mumbai City, Ratnagiri, Raigad, Sindhudurg, Thane Orissa – Baleshwar, Jajapur, Koraput, Nayagarh, Ganjam, Khordha Tamilnadu – Cuddalore, Kanchipuram, Perambalur, Virudunagar, Sivaganga, Tiruvallur West bengal – Kolkata, Pashchim Medinipur, Purba Medinipur
3-4	Andhra Pradesh - Nellore Kerala – Kannur, Kottayam Orissa – Anugul, Dhenkanal Tamilnadu – Ariyalur, Erode, Namakkal, Thanjavur West Bengal – Haora, Hugli
2	Andhra Pradesh - Prakasam Bihar – Jhanabad, Lakhisarai, Munger Kerala – Palakkad, Pattanamtitta, Thiruvananthapuram



Results-temperature, rainfall, relative humidity and wind speed (*rabi*)

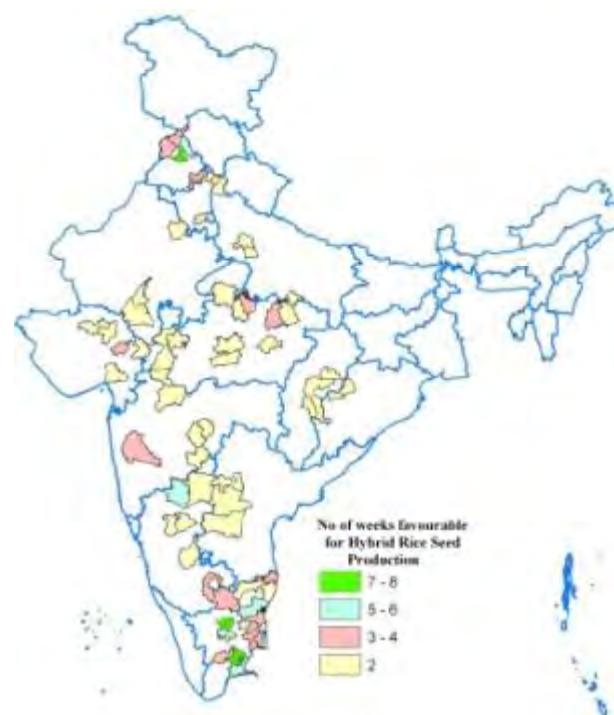
Mean temperature -25-30°C; Difference between day and night temperatures -(5-10°C);
Rainfall -0-3 mm and 0-10 mm; Relative Humidity -55-70%; Wind Speed - 0-3 m/s



Results-temperature, rainfall, relative humidity and wind speed (*kharif*)

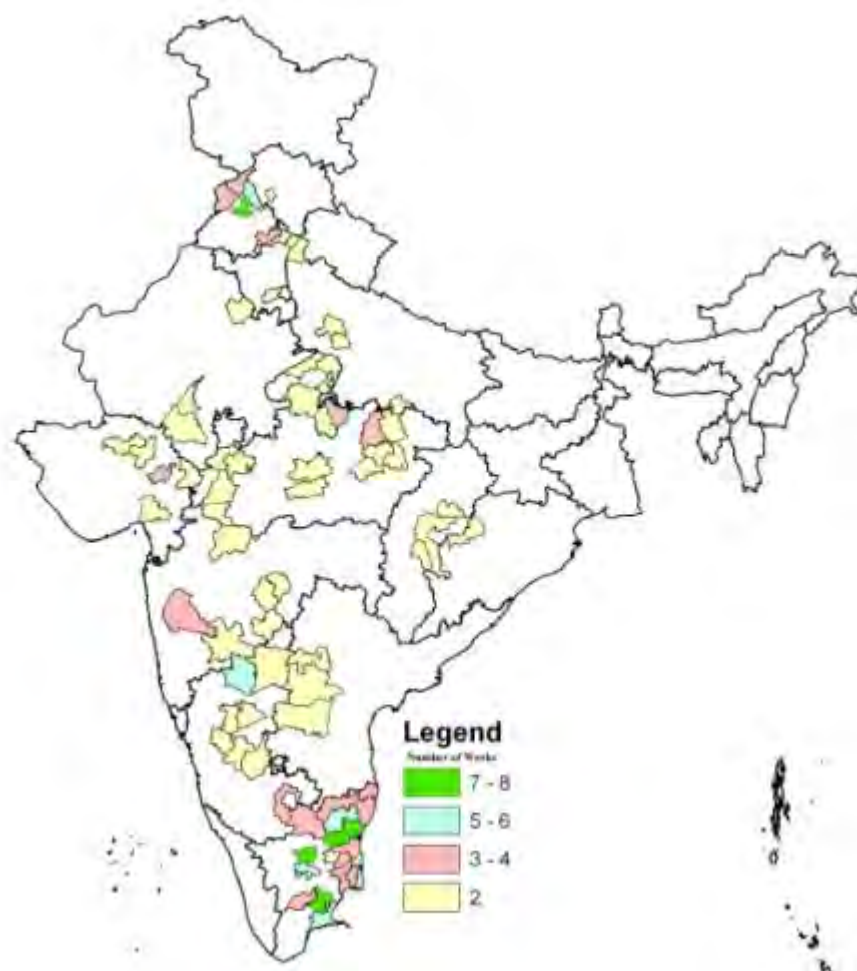
Mean temperature -25-30°C; Difference between day and night temperatures -(5-10°C);
Rainfall -0-3 mm; Relative Humidity -70-80%; Wind Speed - 0-3 m/s

No. of favourable weeks	States(Districts)
7-8	Punjab - Jalandhar Tamilnadu – Namakkal, Sivaganga
5-6	Karnatka - Bijapur Punjab - Hoshiarpur Tamilnadu – Karur, Nagappattinam, Ramanathapuram,



Results-temperature, rainfall, relative humidity and wind speed (*kharif*)

Mean temperature -25-30°C; Difference between day and night temperatures -(5-10°C);
Rainfall -0-10 mm; Relative Humidity -70-80%; Wind Speed - 0-3 m/s



Results-temperature, rainfall, relative humidity and wind speed (*kharif*)

Mean temperature -25-30°C; Difference between day and night temperatures -(5-10°C);
Rainfall -0-10 mm; Relative Humidity -70-80%; Wind Speed - 0-3 m/s

No. of favourable weeks	States(Districts)
7-8	Punjab - Jalandhar Tamilnadu – Namakkal, Villupuram, Sivaganga
5-6	Karnatka - Bijapur Punjab - Hoshiarpur Tamilnadu – Karur, Nagappattinam, Ramanathapuram, Tiruvannamalai
3-4	Karnatka - Bangalore rural Madhya Pradesh - Panna Punjab – Amritsar, Gurdaspur , Patiala Tamilnadu – Chennai, Cuddalore, Thiruvarur Gujarat - Kheda Madhya Pradesh -Tikamgarh Maharashtra - Pune Tamilnadu – Ariyalur, Dharmapuri, Kanchipuram Madurai, Thanjavur, Tiruvallur, Vellore
2	Andhra Pradesh – Kurnool, Mahbubnagar, Rangareddy Chhattisgarh – Dhamtari, Janjgir, champa, Raipur Gujarat – Bharuch, Dahod, Mahesana, Patan Haryana – Ambala, Jhajjar, Yamunanagar Himachal Pradesh – Hamirpur Karnatka – Chitradurga, Davangere, Gadag, Gulbarga, Haveri, Koppal Madhya Pradesh – Barwani, Bhind, Datia, Dhar, Hoshangabad, Jabalpur, Katni,Morena, Raisen, Ratlam,Satna, Shivpuri, Ujjain, Umaria Maharashtra – Hingoli, Jalgaon, Latur; Parbhani' Solapur Orissa- Baragarh Rajasthan – Jhunjhunun, Raj samand, Udaipur Tamilnadu - Perambalur



Results

A few alternate areas identified for large scale seed production during rabi season

No. of favourable weeks during flowering (February and March months)	States (Districts)
7-8	A.P (Khammam), Karnataka (Kaveri, Udupi) North Goa, Tamil Nadu (Dharmapuri, Madurai, Tiruvnnamalai, Vellore, Karur, Pudukottai, Tirunelveli, Tullukudi), Kerala (Trissur)
5-6	Kerala (Malapuram), Odisha (Malkargiri, Baleshwar, Tajapur, Korput, Naya).



Rabi - Districts with <5 weeks favourable seasonal conditions for hybrid seed production

STATE	DIST	INDIAD PO_1	TotalDist	21	22	23	24	31	32	33	34	
ANDHRA PRADESH	NELLORE	287	3					1		1	1	
ANDHRA PRADESH	PRAKASAM	316	2						1		1	
BIHAR	JHANABAD	1441	2								1	1
BIHAR	LAKHISARAI	2704	2								1	1
BIHAR	MUNGER	2702	2								1	1
KERALA	KANNUR	72	3				1	1	1			
KERALA	KOTTAYAM	228	3							1	1	1
KERALA	PALAKKAD	300	2								1	1
KERALA	PATTANAMTI TTA	309	2		1	1						
KERALA	THIRUVANAN THAPURAM	407	2			1		1				
ORISSA	ANUGUL	1121	4				1	1	1	1		
ORISSA	DHENKANAL	1122	3				1	1	1			
TAMILNADU	ARIYALUR	4034	4					1	1	1	1	
TAMILNADU	ERODE	310	4				1	1	1		1	
TAMILNADU	NAMAKKAL	3492	3		1	1	1					
TAMILNADU	THANJAVUR	545	3					1		1	1	
WEST BENGAL	HAORA	163	4					1	1	1	1	
WEST	HUGLI	171	3					1	1	1		



Kharif - Districts with <5 weeks favourable seasonal conditions for hybrid seed production

STATE	DIST	INDIADPO_1	TotalDist	81	82	83	84	91	92	93	94
ANDHRA PRADESH	KURNOOL	232	2							1	1
ANDHRA PRADESH	MAHBUBNA GAR	248	2							1	1
ANDHRA PRADESH	RANGAREDDY	336	2							1	1
CHHATTISGARH	DHAMTARI	3282	2							1	1
CHHATTISGARH	JANJGIR CHAMPA	6203	2							1	1
CHHATTISGARH	RAIPUR	3281	2							1	1
GUJARAT	BHARUCH	5001	2							1	1
GUJARAT	DAHOD	3022	2						1	1	
GUJARAT	MAHESANA	251	2					1	1		
GUJARAT	PATAN	2510	2					1	1		
HARYANA	AMBALA	1401	2							1	1
HARYANA	JHAJJAR	3412	2				1	1			
HARYANA	YAMUNANA GAR	1402	2							1	1
HIMACHAL PRADESH	HAMIRPUR	162	2						1	1	
KARNATKA	CHITRADURGA	86	2							1	1
KARNATKA	DAVANGERE	4172	2							1	1
KARNATKA	GADAG	1101	2							1	1
KARNATKA	GULBARGA	155	2				1			1	
KARNATKA	HAVERI	1102	2							1	1
KARNATKA	KOPPAL	3262	2							1	1
MADHYA PRADESH	BARWANI	4351	2							1	1
MADHYA PRADESH	BHIND	53	2							1	1
MADHYA PRADESH	DATIA	101	2						1	1	
MADHYA PRADESH	DHAR	108	2							1	1
MADHYA PRADESH	HOSHANGABAD	1691	2							1	1
MADHYA PRADESH	JABALPUR	1761	2							1	1
MADHYA PRADESH	KATNI	1762	2							1	1
MADHYA PRADESH	MORENA	2692	2						1	1	



Conclusion

The districts having favourable weather parameters for 7-8 and 5-6 weeks are the most ideal

The districts which have <5 favourable week, minor adjustments in sowing are required so that flowering coincides when the weather conditions are favourable

This preliminary study revealed that, for the *Rabi* season, 13 districts in 6 states are most ideal for hybrid rice seed production.

Further fine tuning is needed to strengthen the above study for identifying alternative locations for hybrid seed production with detailed grid based weather data before going for pilot seed production



Thank You

