Study of crop weather relationship

Macro level study

- Ramdas data
  - 5 crops – rice , wheat, sorghum, cotton, sugar cane
  - 20 stations – all over the country
  - Two varieties at each station – one local, one national
  - 25 years –1946- 1972

- Records
  - From sowing to harvest
    - Dates of important events e.g. sowing, end of germination, end of growth etc.
    - Measures of crop development e.g. % germination Height of plant, yield etc.
    - Corresponding weather data

Objectives

- Early prediction of yield
- Weather component of yield variability
- **How to begin?**
- Development phases that can be modeled
  - Seed germination
  - Plant growth
  - Yield

Modeling of seed germination

- Data: daily % germination

- Model : Hyperbolic – shifted origin
  - Initial stage not observable(first 3 /4 days)
  - Total period 10-15 days

$$Y = V(x-x_0) / (K+(x - x_0))$$

Where; x – days since sowing

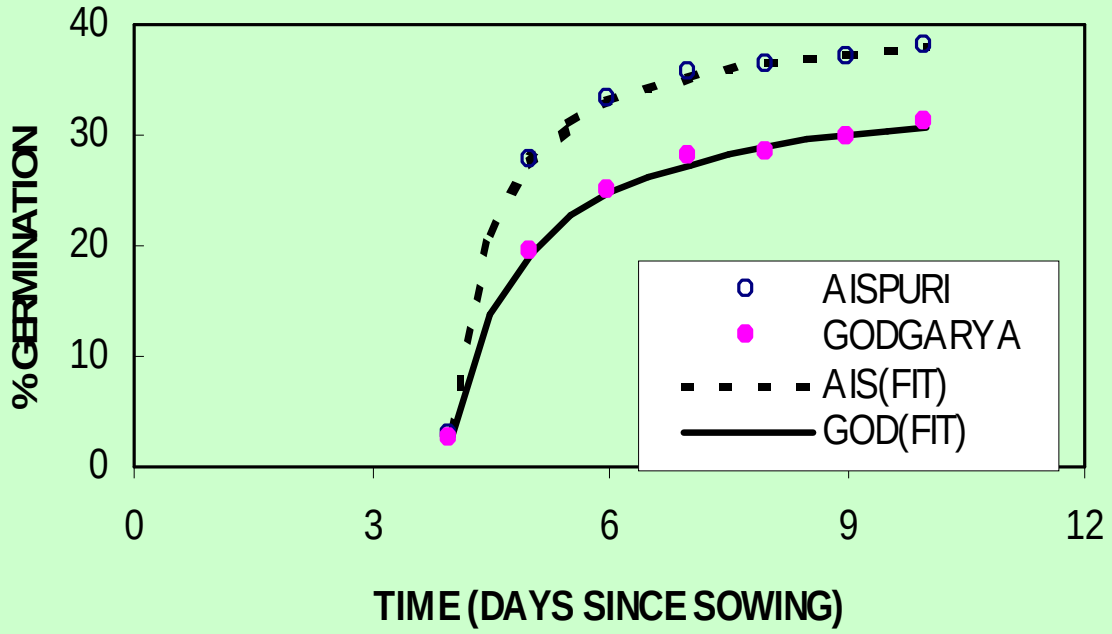
x_0 - shift

Y - % germination up to x days

V- max germination

K – half saturation constant

(time when % germination if V/2)



Parameter	Ais	God
V	41.04	35.07
K	.5	.86
x_0	3.96	3.94

Meta model

- V,K regressed on weather
  - 1 week pre sowing, 1 week after sowing

	R^2	error d.f.
Aispuri		
V= - 101.84 + 0.40 RHH2	81%	4
K= 0.85 -0.0005 MWV	26%	4
Godgarya		
V= - 110.5 + 0.42 RHH2	80%	8
K= 3.14 -0.0024 MWV	34%	8

V- environment sensitive, K-genetic?

- Use : anticipate failure of germination
  - Action – re-sowing

Modeling plant growth

- Data – weekly / fortnightly height records of plants
- Model sigmoidal – logistic
  - K, r parameters – K- max height, r growth rate
- Meta model
  - Relate K, r to weather
- Literature – degree days play a measure role in growth phase
  - Degree days – sum of excess over 15^0 C in each day
  - Temp below 15^0 C not favorable for growth
- Use early prediction of K – prediction of straw yield

Results of meta model

- **Degree days in first 10 weeks after sowing are considered**

• **Aispuri**	R^2	error d.f.
K = - 77.0 + 0.45W1 +0.99 W5 +1.28 W7 –0.72W9	47%	15
r = - 0.01 + 0.0001 W1 – 0.0002 (W2-W4)+ 0.0005 W7	57%	15

• **Godgarya**	R^2	error d.f.
K = - 225.0 + 0.94W1 +1.31 W5 +1.48 W7 –0.57W9	48%	15
	very low	15

Only one weather variable(degree days) used is inadequate. Additional variables may improve R^2.

Predicting yield using biometrical and weather variables

- **Biometrical variables**:
  - Growth indicators at earlier phases of crop development
    e.g. germination %, max plant height, max # shoot/ plant etc.
  - Contain information about weather up to that phase
  - not adequate to explain yield variability by themselves
  - Weather after completion of plant growth needs to be considered
  - Weather in 2 weeks after completion of plant growth is considered
    - 2 months before harvest
    - Early enough

Regression model for Sorghum yield (Grain- Solapur)

Predictor variables

Variety 1(M-35-1)	Variety 2 (ND15)
Max height	Max ears/sample
Max shoots/sample	Max shoots/sample
DB1W2	DB1W1
WB1W1	WB1W1
WB1W2	ST1W2
ST1W1	RH1W2
RH1W2	--
R^2 = 85%	85%
d.f.(error)= 9	10

Regression model for Paddy yield (Grain- Karjat)

Predictor variables

Variety 1(K-42)	**Variety 2 (no name)**
Max height	**Max height**
Max no of ears	**--**
DB1W2	**DB1W1, DB1W2**
WB1W2	**WB1W1, WB1W2**
MaxTW2	**MaxTW1**
MinTW2	**MinTW1, MinTW2**
VP1W2	**--**
RH1W2	**RH1W1**
R^2 = 87%	**78%**
d.f.(error)=11	**10**

Regression model for Paddy yield (Straw)

Predictor variables

Variety 1(K-42)	Variety 2 (no name)
Max # shoots	--
Max # of ears	--
DB1W1, DB1W2	DB1W2
WB1W2	WB1W1, WB1W2
MaxTW2	MaxTW1
---	MinTW2
VP1W1	VP1W1
RH1W1	RH1W1, RH1W2
R^2 =75%	75%
d.f.(error) = 11	9

Weather component of yield variability

- Factors affecting yield
  - Variety chosen
  - Locality (soil, climate)
  - Weather of that year
  - Agronomic practices

Ramdas data: agronomic practices standardized across stations.

Varieties fixed for a station over years, but change between stations.

Varieties treated as a random effect.

Variation in yield from year to year for a given station and variety – weather effect

Nested model – Station(variety (year(error)))

Separating error from year? Multiple plots in the same year.

Variance components (sorghum grain yield)

Source	d.f.	% variance
Station	4	43.0
Variety	5	0.0
Year (weather)	108	39.0
Error	584	18.0

Variance Components (Paddy Grain Yield-Karjat)

Source	d.f.	% of Total
variety	1	3.21
year (weather)	32	64.56
Error	374	32.23
Total	407	