Crop Yield Forecast using Agromet Model

A.K. Baxla
Scientist-E
Agromet Advisory Service Division
OUTLINE

• Weather Monitoring & Forecasting
• Background of AAS system
• Agromet Models and Database
• In-season Crop Yield Forecast
• Future Plan
Weather Monitoring & Forecasting
Weather Observation System

Automatic Weather Stations (675)

Automatic Rain Gauge Stations (1289)

Surface Observatories

Agrometeorological Observatories (264)

Location of DRMS

Doppler Weather Radar (22)
Gridded Weather data

Rainfall: 1.0*1.0 degree,
         0.5*0.5 degree,
         0.25*0.25 degree

Max & Min Temperature: 1.0*1.0 degree
                        0.5*0.5 degree

Satellite data:
(for use in crop model) Insolation,
Land Surface Temperature (LST),
Soil Moisture,
NDVI based sowing dates.
Nowcast
Thunderstorm
Hailstorm
Squall

Medium Range Forecast

- GFS-T1534
- Spatial Res. 12.5 km
- Forecast for 10 days
Extended Range Forecast for Rainfall, Max and Min. Temp.

### Validity Period

<table>
<thead>
<tr>
<th>Week 1</th>
<th>(03-09 Mar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast of circulation and rainfall</td>
<td></td>
</tr>
<tr>
<td>Southern peninsular India, north east and parts of extreme north India will be active during the week.</td>
<td></td>
</tr>
<tr>
<td>$T_{min}$ will be mostly below normal over the central parts of the country and extreme north India.</td>
<td></td>
</tr>
<tr>
<td>Except some parts of northwest India and parts of northeast India $T_{max}$ will be mostly above normal over the country.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 2</th>
<th>(10-16 Mar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost similar rainfall belt like in week 1 with slight increase of rainfall over northeast India and decrease over south peninsula India.</td>
<td></td>
</tr>
<tr>
<td>$T_{min}$ will be mostly below normal over the country.</td>
<td></td>
</tr>
<tr>
<td>$T_{max}$ will be mostly normal to slightly below normal.</td>
<td></td>
</tr>
</tbody>
</table>

### Outlook for Week 3 and Week 4

<table>
<thead>
<tr>
<th>Week 3</th>
<th>(17-23 Mar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No major rainfall activity</td>
<td></td>
</tr>
<tr>
<td>$T_{min}$ will be normal to below normal over most of eastern belt (except some parts of NW India) during week 3 and week 4.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 4</th>
<th>(24-30 Mar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{max}$ will be mostly above normal mainly in week 4.</td>
<td></td>
</tr>
</tbody>
</table>

### Inference

Flowchart of ERFS

ERFS forecast

Realized forecast from Hydromet division Pune

Draft bulletins from various AMFUs ACROSS THE COUNTRYS

INPUTS

subdivision wise realized weather

CRIDA Hyderabad prepare final ERFS bulletin focused on

subdivision wise forecast

Selection of varieties and date of sowing

Farm activities

Contingency planning

Selection of date of harvesting

National Agromet Advisory Service Bulletin based on
Extended Range Weather Forecast (ERFS)
Valid for 16th to 29th September, 2016
Date of Issue: 16th September, 2016

Issued by
Earth System Science Organization
India Meteorological Department

Indian Council of Agricultural Research (ICAR)
All India Coordinated Research Project on Agricultural Meteorology (AICRAMP),
Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad

*National AAI Bulletins related to ERFS is available at http://www.indianmet.gov.in/erfsinfo*
Long Range Forecast

Summary of 1st Stage Forecast issued on 12th April, 2016

(a) Quantitatively, the monsoon seasonal rainfall is likely to be 106% of the Long Period Average (LPA) with a model error of ± 5%. The LPA of the season rainfall over the country as a whole for the period 1951-2000 is 89 cm.

(b) The 5 category probability forecasts for the Seasonal (June to September) rainfall over the country as a whole is given below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Rainfall Range (% of LPA)</th>
<th>Forecast Probability (%)</th>
<th>Climatological Probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficient</td>
<td>&lt; 90</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Below Normal</td>
<td>90 - 96</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Normal</td>
<td>96-104</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>Above Normal</td>
<td>104-110</td>
<td>34</td>
<td>16</td>
</tr>
<tr>
<td>Excess</td>
<td>&gt; 110</td>
<td>30</td>
<td>17</td>
</tr>
</tbody>
</table>


Second Stage Forecasts to be issued now....

- Forecast update for the southwest monsoon season (June-September) rainfall over the country as a whole using a 6-parameter ensemble statistical model with a model error of ± 4%.

- Forecast for the monthly rainfall over the country as a whole for the months of July & August using separate principle component regression models with a model error of ± 9%.

- Forecasts for the southwest monsoon season (June-September) rainfall for the following four broad geographical regions of India using separate principle component regression models with a model error of ± 8%.
District Level Agromet Advisory Service System

IMD

Agromet Data

130 Agromet Field Units

PREPARATION OF DISTRICTS WISE MEDIUM RANGE WEATHER FORECAST BY STATE MET CENTER

District Level Agencies (DAO/KVK/ATMA/NGO’s)

DISSEMINATION OF DISTRICT LEVEL AGRO-ADVISORIES

Feedback Analysis

PREPARATION OF DISTRICT SPECIFIC AGRO-ADVISORIES FOR AGROCLIMATIC ZONE

Agromet Data

Farmers (THROUGH MEDIA, AGENCIES, IT SERVICES, PERSONAL CONTACT)
Network under Gramin Krishi Mausam Sewa

- 23 AAS Units Of IMD
- 130 Agromet Field Unit at SAUs & ICAR Centres
- 35 AICRPAM Centres under ICAR
- DAMUs at KVK
Crop Specific Advisory Bulletin

Advisory generation by AMFUs Expert Panel
Agronomist, Agrometeorologist, Entomologist, Soil Scientist, Pathologist, District Agriculture Officer Etc.

Forecast issued by Met Centre for Agriculture
Twice a week i.e. Tuesday & Friday

Forecast & Crop advisory dissemination to farmers
Mass Media, DD Kisan, SMS through m-Kisan & PPP partners
Proposed Mechanism of further dissemination at Village level involving other organization

Outreach to ~95 million farmers

Farmers feedback through SMS
Plan for App based feedback system

- PPP: IFFCO, Reliance, HCL, RML, Mahindra Samriddhi, Kisan Samachar, Handygo
- NIC
- State Agricultural Production Commissioners
- Postal Department
- Digital India
- ICAR
- Extension Agencies like ATMA, KCCs, VRCs
- DD Kisan, Community Radio, FM, Cable network
- Postal Department
- Digital India
- ICAR
Agromet Models and Database
FASAL (Forecasting Agriculture using Space, Agrometeorology and Land based observations)

Objective: Providing multiple pre-harvest production forecasts of crops at National/State/District level

Forecast schedule:
- F1: Vegetative
- F2: Flowering
- F3: Pre-Harvest stage.

Crops under FASAL
- Rice
- Wheat
- Maize
- Jowar
- Bajra
- Ragi
- Groundnut
- Sugarcane
- Rape seed & Mustard
- Cotton
- Jute

Crops under CHAMAN
- Potato
- Tomato
- Chilli
- Onion
- Mango
- Banana
- Citrus
AGROMET MODELS

- Statistical Models
- Crop Simulation Models
Statistical model based on weather indices

- Correlation coefficients after adjusting yield for trend effect
- Effects as linear function of respective correlation coefficients
- Effects of quadratic terms of weather

\[
Y = A_0 + \sum_{i=1}^{p} \sum_{j=0}^{1} a_{ij} Z_{ij} + \sum_{i \neq i'=1}^{p} \sum_{j=0}^{1} a_{ii'j} Z_{ii'j} + cT + e
\]

Where,

\[
Z_{ij} = \sum_{w=1}^{m} r_{iw}^j X_{iw} \quad \text{and} \quad Z_{ii'j} = \sum_{w=1}^{m} r_{ii'w}^j X_{iw} X_{i'w}
\]

- Models using correlation coefficients based on yield adjusted for trend effect better
- Inclusion of quadratic terms of weather did not improve the model
- Second power of correlation coefficient did not improve the model

- $r_{iw}$ is correlation coefficient of yield with $i^{th}$ weather variable $(x)$ in $w^{th}$ period
- $r_{ii'w}$ is correlation coefficient of yield with product of $i^{th}$ and $i'^{th}$ weather variables $(x)$ in $w^{th}$ period
- $m$ is period of forecast
- $p$ is number of weather variables used
- $e$ is random error distributed as $N(0, \sigma^2)$.
- $T$ is technology factor
## Rice yield forecast (F2), 2015-16 using Statistical Model for West Bengal

<table>
<thead>
<tr>
<th>SN</th>
<th>District</th>
<th>Equation</th>
<th>Weather Parameters</th>
<th>Forecast Yield (kg/ha)</th>
<th>$R^2$</th>
<th>F</th>
<th>Std Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cooch Behar</td>
<td>$Y=3652.94+37.91,*,\text{Time}+,12.37,*Z51-0.01,*Z230$</td>
<td>RHII, Tmin*RH</td>
<td>2077</td>
<td>0.93</td>
<td>64</td>
<td>92</td>
</tr>
<tr>
<td>2</td>
<td>Jalpaiguri</td>
<td>$Y=3045.95+43.96,*,\text{Time}+,53.93,*Z21+0.18,*Z41-4.04,*Z21$</td>
<td>Tmin, RH,</td>
<td>2032</td>
<td>0.94</td>
<td>58.6</td>
<td>79.8</td>
</tr>
<tr>
<td>3</td>
<td>South Dinajpur</td>
<td>$Y=1338.07+57.32,*,\text{Time}+,1.44,*Z31$</td>
<td>RF</td>
<td>2807</td>
<td>0.92</td>
<td>136</td>
<td>123</td>
</tr>
<tr>
<td>4</td>
<td>Uttar Dinajpur</td>
<td>$Y=1245.73+48.29,*,\text{Time}+,0.76,*Z151+0.10,*Z150$</td>
<td>Tmax*RHII,</td>
<td>2647</td>
<td>0.89</td>
<td>77</td>
<td>136</td>
</tr>
<tr>
<td>5</td>
<td>Burdwan</td>
<td>$Y=188.33+43.77,*,\text{Time}+,0.77,*Z231+0.271,*Z251$</td>
<td>Tmin<em>RF, Tmin</em>RHII</td>
<td>3207</td>
<td>0.80</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>Mursidabad</td>
<td>$Y=1740.92+36.01,*,\text{Time}+,0.25,*Z451+0.04,*Z131+0.78,*Z251$</td>
<td>Tmax, Tmin, Rainfall, RHI, RHII</td>
<td>2830</td>
<td>0.89</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>Nadia</td>
<td>$Y=1623.00+27.54,*,\text{Time}+,3.45,*Z121+0.04,*Z131+2.14,*Z151+0.53,*Z150$</td>
<td>Tmax<em>Tmin, Tmax</em>RF, Tmax*RHII</td>
<td>2680</td>
<td>0.84</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>8</td>
<td>Howrah</td>
<td>$Y=3056.37+7.09,*Z141+2.18,<em>Z140+16.85,</em>\text{Time}+0.02,*Z341$</td>
<td>Tmax<em>RHI, RF</em>RHI</td>
<td>1482</td>
<td>0.76</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>9</td>
<td>Hooghly</td>
<td>$Y=2164.86+50.91,*,\text{Time}-0.24,*Z351+208.24,*Z41+142.46,*Z51-1.15,*Z451+0.75,*Z131$</td>
<td>RF<em>RHII, RHI, RHII, RHI</em>RHII, Tmax*RF</td>
<td>3651</td>
<td>0.90</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>10</td>
<td>North 24 Parganas</td>
<td>$Y=,-2872.60+41.32,\text{Time}+,1.14,*Z151+1.20,*Z241$</td>
<td>Tmax<em>RHII, Tmin</em>RHI</td>
<td>2834</td>
<td>0.89</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>11</td>
<td>West Midnapur</td>
<td>$Y=,975.68+\text{Time}<em>45.67+Z120</em>3.77$</td>
<td>Tmax*Tmin</td>
<td>2839</td>
<td>0.87</td>
<td>91.82</td>
<td>273.89</td>
</tr>
<tr>
<td>12</td>
<td>Bankura</td>
<td>$Y=,1674.88+\text{Time}*43.27$</td>
<td>---</td>
<td>3059</td>
<td>0.80</td>
<td>122.0</td>
<td>433.57</td>
</tr>
<tr>
<td>13</td>
<td>Birbhum</td>
<td>$Y=,1737.32+\text{Time}*48.85$</td>
<td>---</td>
<td>3300</td>
<td>0.84</td>
<td>154.2</td>
<td>468.80</td>
</tr>
<tr>
<td>14</td>
<td>Purulia</td>
<td>$Y=,7831.85+\text{Time}<em>29.04+Z11</em>114.91+Z151*0.41$</td>
<td>Tmax, Tmax*RHII</td>
<td>2468</td>
<td>0.85</td>
<td>50.6</td>
<td>429.33</td>
</tr>
<tr>
<td>15</td>
<td>Malda</td>
<td>$Y=,58.707+\text{Time}<em>146.53+Z11</em>0.05+Z231+2714.88$</td>
<td>Tmax, Tmin*RH</td>
<td>3065</td>
<td>0.92</td>
<td>100.5</td>
<td>167.12</td>
</tr>
<tr>
<td>16</td>
<td>South 24 Parganas</td>
<td>$Y=,34.48+\text{Time}<em>91.88+Z11</em>0.73+Z31+46.66*Z41+520.41$</td>
<td>Tmax, RF, RHI</td>
<td>2171</td>
<td>0.89</td>
<td>48.8</td>
<td>135.31</td>
</tr>
<tr>
<td>17</td>
<td>East Midnapore</td>
<td>$Y=,125.15+169.43,*,\text{Time}+,0.05,*Z351$</td>
<td>RF*RHII</td>
<td>2724</td>
<td>0.73</td>
<td>29.7</td>
<td>178.2</td>
</tr>
</tbody>
</table>
Crop Growth Simulation Models

Crop Growth Simulation Model estimates

1. Phenological development or duration of growth stages as influenced by plant genetics, weather, and soil factors.

2. Growth of leaves, stems, roots and grains

3. Biomass production and partitioning

4. Effects of soil-water deficit and nitrogen deficiency on photosynthesis and photo-synthate partitioning in the plant system.
Agricultural Models - System approach

Used under Indian condition

- DSSAT
- WOFOST
- APSIM
- EPIC
- WTGROWS
- INFOCROP
- ORYZA
- BRASSICA
What are the Crops covered

<table>
<thead>
<tr>
<th>Cereals</th>
<th>Legumes</th>
<th>Oil seeds</th>
<th>Tuber crops</th>
<th>Horticultura l Crop</th>
<th>Cash Crop /other crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Chickpea</td>
<td>Canola</td>
<td>Cassava</td>
<td>Pepper</td>
<td>Sugar cane</td>
</tr>
<tr>
<td>Maize</td>
<td>Cowpea</td>
<td>Sunflower</td>
<td>Potato</td>
<td>Cabbage</td>
<td>Cotton</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>Dry bean</td>
<td>Mustard</td>
<td>Tanier</td>
<td>Tomato</td>
<td>Bahia Grass</td>
</tr>
<tr>
<td>Rice</td>
<td>Faba bean</td>
<td></td>
<td>Taro</td>
<td>Sweet corn</td>
<td>Brachiaria</td>
</tr>
<tr>
<td>Sorghum</td>
<td>Lentil</td>
<td></td>
<td></td>
<td>Green bean</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>Peanut</td>
<td></td>
<td></td>
<td>Pineapple</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pigeon pea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soybean</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Velvet bean</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Moong bean</td>
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<td></td>
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</tr>
</tbody>
</table>
INPUTS: Minimum Data Set

**Weather Variables**
- Solar radiation / bright sunshine hours
- Maximum air temperature
- Minimum air temperature
- Precipitation
- Latitude (to calculate day length)

**Soil Variables**
- General Soil classification
- Surface slope & Albedo
- Runoff
- Permeability & Drainage
- First stage soil evaporation

**For each Soil layer**
- Wilting point
- Field Capacity
- Saturated soil water content
- Bulk Density
- Clay & Silt (%)
- Relative root distribution
- Initial soil water content

**Crop Management Variables**
- Cultivar selection (genetic coeff.)
- Planting date
- Plant population
- Row spacing
- Irrigation (dates and amount)
- Fertilizer (dates and amount)
- Initial conditions
- Crop rotations
- Pest (damage)
Network programme

- **ICAR- AICRPAm**: All India coordinated Research Programme on Agro meteorology- 25 locations

- **FASAL**: 47 Agro-Met Field Units in different agro-climatic zones

**Crop Model calibration, validation and sensitivity analysis**:

- Continuous evolution of model by field experimental testing across diverse environment, soil and cultural practices
- Information feedback from scientist/farmers and farm managers
Field Experimental Layout

Field experiments proposed under FASAL project consider following aspects

- 1 or 2 popular cultivars grown in the region for each crop under study
- 3-4 Date of sowing
- N management - Time, amount and method of application
- Phenology
- Growth - Biomass at different stages
- LAI and soil moisture at different stages
- Crop observations serve purpose of ground truth for RS data to link with CSM
Indian workers have derived Genetic coefficients for few ruling cultivars of following crops in different agro-climatic zones –

- Rice, Wheat, Maize, Sorghum, Millet, Peanut, Soybean, Sugarcane, potato, chickpea, Sunflower

- A new crop cultivar needs model calibration and validation to derive the G.C. This requires crop observations from field experiments.
Available Database

Crop data
- Area, Production & Productivity - district wise, 1990 onwards for all major crops of India
- Genetic coefficient of all major crops derived from field experiments

Weather Data

Soil Data
- Layer wise Hydro-physico-chemical properties required for CSM - district wise

Crowd sourcing is done regularly to improve the data accuracy through different networks.
District wise soil information - Layer 1

- **Wilting Point**
- **Field Capacity**
- **Saturation**
- **Organic Carbon**
Model Evaluation in Farmer’s field: CCE Yield Vs. Simulated Yield of Kharif Rice 2014

- Shimoga
- Yadgiri
- Raichur: Rabi (2014-15)
- Bulandshahr
- Pratapgarh
- East Godavari
- East Godavari
- Srikakulam
- Bardhamaan

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Bharat Mousam Vigyan Vigyan
INDIA METEOROLOGICAL DEPARTMENT
In-season Crop Yield Forecasting

Methodology & Result
Spatial Crop Yield Forecasting: Methodology and Data flow

**Static Data**
- Soil
- Crop and Management practices
  (Past experimental data for different cultivars)
  (Source: AMFUs & IMD)
- Used to calibrate, validate crop Model
- On going field Experiments
  (Source: AMFUs)

**Dynamic Data**

**Weather**
- Observed: Daily Tmax, Tmin, Rain Radiation
  (Source: MC/AMFU)
- Daily normal or Forecast
  (Source: MC)

**Crop**
- Cultivars
  (Normal/excess or deficit monsoon)
  (Source: SAUs)
- Area sown/transplanted
  (Source: DAC, SDA)

**Management**
- Time of sowing
- Irrigated/Rainfed
- N & Water schedule
  (Source: SAUs)

**RS Product**
- NDVI
- LAI
- Soil Moisture
  (Source: SAC)

**CROP MODEL**
(DSSAT v4.5, INFOCROP)
Run at AMFU & MC

**Stage -2 output**
Yield estimates & other parameters

**Stage -1 Output**
- Phenology
- Growth
- Water Balance

**Refinement in crop Model**
(New genetic coefficients)

**Verification using RS data**
(Adjust sowing date in crop model)
Crop Simulation Model based operational district level Rice Yield Forecast Kharif -2015
Model performance for Rice Yield for different state-2015

Source: DAC&FW (MoAg&FW)
### Observed and forecasts (kg ha\(^{-1}\)) Wheat yield in 2011-12, 2012-13 and 2013-14 for various stations representing different agroclimatic zones of Uttar Pradesh

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Stations</th>
<th>2011-12</th>
<th></th>
<th>2012-13</th>
<th></th>
<th>2013-14</th>
<th></th>
<th>R(^2)</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Observe</td>
<td>Forecast</td>
<td>Observe</td>
<td>Forecast</td>
<td>Observe</td>
<td>Forecast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Allahabad</td>
<td>2628</td>
<td>2717</td>
<td>2435</td>
<td>2509</td>
<td>2531</td>
<td>2683</td>
<td>0.93</td>
<td>110.3</td>
</tr>
<tr>
<td>2</td>
<td>Bahraich</td>
<td>3070</td>
<td>3407</td>
<td>2841</td>
<td>2904</td>
<td>3231</td>
<td>3554</td>
<td>0.98</td>
<td>271.9</td>
</tr>
<tr>
<td>3</td>
<td>Faizabad</td>
<td>2956</td>
<td>2967</td>
<td>2663</td>
<td>2895</td>
<td>2470</td>
<td>2718</td>
<td>0.94</td>
<td>196.1</td>
</tr>
<tr>
<td>4</td>
<td>Jhansi</td>
<td>3130</td>
<td>3444</td>
<td>2792</td>
<td>3342</td>
<td>2691</td>
<td>2814</td>
<td>0.78</td>
<td>372.4</td>
</tr>
<tr>
<td>5</td>
<td>Kanpur</td>
<td>3311</td>
<td>3760</td>
<td>3555</td>
<td>4003</td>
<td>3480</td>
<td>3678</td>
<td>0.55</td>
<td>383.6</td>
</tr>
<tr>
<td>6</td>
<td>Lucknow</td>
<td>2717</td>
<td>3038</td>
<td>2713</td>
<td>3158</td>
<td>2630</td>
<td>2951</td>
<td>0.79</td>
<td>367.0</td>
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<tr>
<td>7</td>
<td>Modipuram</td>
<td>4278</td>
<td>4530</td>
<td>4129</td>
<td>4284</td>
<td>4065</td>
<td>4635</td>
<td>0.82</td>
<td>269.8</td>
</tr>
<tr>
<td>8</td>
<td>Varanasi</td>
<td>2933</td>
<td>3425</td>
<td>3014</td>
<td>3370</td>
<td>2720</td>
<td>2817</td>
<td>0.94</td>
<td>355.0</td>
</tr>
</tbody>
</table>

#### Dev (%) of Uttar Pradesh

- **2011-12**
- **2012-13**
- **2013-14**

**Stations / Districts**

**Indian Meteorological Department**
Observe
ed
Forecast
Observe
ed
Forecast
Observe
ed
Forecast

1
Pusa     2840    3158    2954    3389    3740    3987    0.86
         566.7
2
Sabour   3111    3469    3225    3548    2713    3025    0.99
         548.8
3
Agwanpur 2170    3012    2284    2897    2119    2845    0.99
         661.1

Observed and forecasts (kg ha\(^{-1}\)) Wheat yield in 2011-12, 2012-13 and 2013-14 for various stations representing different agroclimatic zones of Bihar
Wheat Yield forecast and % deviation for the year 2013, 2014 and 2015 for Uttar Pradesh & Bihar
Comparison between Wheat & Rice yield forecast & Observed Yield

(F2 & F3 stage) for the year 2014

(F2 & F3 stage) for the year 2015

연도 2014, 2015 수확량 예측 결과 비교
Wheat & Rice Yield forecast % deviation for the year 2013, 2014 and 2015
Bottlenecks in developing crop yield forecast

- Long term Meteorological data and/or crop yield data are not available for some districts.
- Poor accuracy of yield forecast models for the regions where there is high variability in weather and crop yield over the years.
- Due to socio-economical & Govt. policy, sudden changes in cultivation practices and varieties causing sharp changes in yield pattern.
- Due to establishment of new districts, there is non-availability of long term weather and yield data for these districts.
- Damage caused due to Extreme events are not accountable in the model.
Automation process include data preparation for crop models and Processing the model for Crop yield Forecast at District Level and at State Level

✓ Weather Data preparation (DSSAT format) in single process for all stations instead of executing the weather module for each station.

✓ Batch Processing of Experiment files for different states at one single process to estimate yield and other crop parameters.

✓ Automatic Extraction of Required crop parameters for different states such as crop yield, Sowing date, Anthesis date, Anthesis day, maturity date, maturity day, LAI, HI etc.)
In season crop outlook using crop modelling techniques

Conceptual Diagram

- Baseline biophysical data
- Meteorological data
- Crop Management Data
- Create Run file for Crop Simulations
- Crop Simulations Using DSSAT Global Interface
- Results and area weightage
Future considerations

• Weekly progress of Area sown under different crops at district scale
• Improvement in Estimation of daily solar radiation using routine weather data such as MaxT, MinT, rain, cloud cover – important during monsoon season. Also Satellite derived insolation (8 km & 4 km res.)
• Improvement in soil data base
• Linking RS data with Crop model
  • Forcing of LAI etc. into CSM at the time of prediction
  • Re-run crop model- adjust sowing date to match simulated crop condition (LAI)
• Use of other crop model -InfoCrop model etc.
• Develop methodology to ensemble/ hybridize the multi crop simulation and statistical models’ estimates to improve final forecast
THANK YOU

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT