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Yield forecasting of wheat and mustard for western Uttar Pradesh using statistical model

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ABSTRACT

Twenty one years (1992-2013) of weather data and yield data of wheat and mustard for 10 districts of western Uttar Pradesh were used to develop yield prediction model. The models were validated with 2014 and 2015 data set. The results revealed that pre harvest forecasting model had R^2 values ranging between 22 and 81 per cent for wheat crop and between 26 and 87 per cent for mustard in the different districts. During both the years of validation the observed yields were in good agreement with forecasted yields for wheat as well as mustard.

Key words : Forecast, wheat, mustard, validate, model

Climate is a primary determinant of agricultural production and changes in climate would likely to have devastating effect on agriculture. Uttar Pradesh ranks first in area (36.58%) and production (36.27%) of wheat in the country. Most of the production comes from the areas of the Ganga-Yamuna Doab and the Rohilkhand plains. Rapeseed-mustard is the second most important edible oilseed after groundnut sharing 27.8 per cent in the India's oilseed economy, (Sekhawat, 2012). Rajasthan is the largest producing state followed by Uttar Pradesh, Haryana, Madhya Pradesh, Gujarat, West Bengal, Bihar and Punjab *etc* (Anonymous, 2009).

Considering the importance of wheat and mustard crop a attempt was made to develop pre harvest yield forecasting models, in the selected districts of western Uttar Pradesh.

MATERIAL AND METHODS

The long period (1992-2015) yield data of wheat and mustard crop were collected from website of Directorate of Economics and Statistics, Department of Agricultural and Coperation, Ministry of Agriculture, Govt. of India(http://eands.dacnet.nic.in/). The standard meteorological week (SMW) wise weather data from 40th to 7th were used to develop regression models for 10 districts (Meerut, Muzafanagar, Saharanpur, Barielly, Bijnor, Moradabad, Pilibhit, Rampur, Aligarh, Badaun) for wheat crop and from 40th to 4th SMW data were used to develop models for six districts of western Uttar Pradesh (Aligarh, Badaun, Bulandshahar, Moradabad, Sahjahnpur and Rampur) for mustard following methodology described by Ghosh *et al*., (2014). The models were validated with observed yield data of 2014 and 2015. The variables used in the study were rainfall (RF, mm), maximum (T_{max}) and minimum (T_{min}) temperature (^{0}C), morning relative humidity (RH I, %) and afternoon relative humidity (RH II, %). Different weather indices were generated using weekly values of weather parameters and their weighted values using correlation coefficient (Table 1).

RESULTS AND DISSCUSSION

Wheat yield forecasting

The wheat yield prediction model developed for 10 districts of western Uttar Pradesh (Table 2) show that minimum temperature (Tmin) is the most important parameters common in all the models. The coefficient of determination R^2 ranged between 0.30 to 0.81 which were significant at P = 0.05. During validation (Table 3), the percent error between observed and predicted were less than 10 implying that these models can be used for predicting the wheat yield in these 10 districts of west U.P. Similar work for eastern Uttar Pradesh has been reported by Singh *et al.* (2014).

Mustard yield forecasting

The models developed for yield forecasting of mustard in six districts of western U.P.(Table 4) show that the R^2

Table1: Weather indices used in models using composite weather variables

Weather parameter	Simple weather indices					Weighted weather indices				
	T max	T min	R/F	RH (I)	RH (II)	T max	T min	R/F	RH (I)	RH (II)
T max	Z10					Z11				
T min	Z20	Z20				Z21	Z21			
R/F	Z30	Z30	Z30			Z31	Z31	Z31		
RH (I)	Z40	Z40	Z40	Z40		Z41	Z41	Z41	Z41	
RH (II)	Z50	Z50	Z50	Z50	Z50	Z51	Z51	Z51	Z51	Z51

Table 2 : Pre-harvest yield forecast model (F3 stage) of wheat crop for different districts of Western Uttar Pradesh

S.No.	District	Equation	R^2	F	Std error
1	Meerut	Y=6118.23+(19.76*Z11)+(18.46*time)+(-.089*Z230)+(.068*Z241)	0.68	42.5	165.2
2	Muzaffarnagar	Y=1672.00+(7.34*Z41)+(.131*Z241)	0.58	27.8	136.7
3	Saharanpur	Y=853.31+(-168*Z131)+(2.48*Z41)	0.64	36.5	153.8
4	Bareilly	Y=3245.65+(49.76*time)+(-0.27*Z240)	0.81	89.7	136.7
5	Bijnor	Y=3103.54+(38.67*time)+(-2.35*Z20)	0.75	61.8	122.9
6	Moradabad	Y=2787.19+(.308*Z151)+(19.45*time)+(0.83*Z241)	0.46	17.6	155.6
7	Pilibhit	Y=2588.23+(53.47*time)	0.68	44.1	239.6
8	Rampur	Y=2672.27+(8.44*Z11)+(.04*Z250)	0.3	8.68	186.1
9	Aligarh	Y=2303.49+(30.30*time)+(6.23*Z31)+(0.21*Z151)	0.41	14.3	205.1
10	Badaun	Y=3207.77+(33.37*time)+(.30*Z251)+(-.075*Z230)+(-2.74*Z20)	0.65	38.81	213.6

Table 3: Observed and forecasted (kg ha^{-1}) yield of wheat crop in 2014 and 2015 for various districts of Western Uttar Pradesh

S.No.	Districts	2014			2015		
		Observed	Predicted	Error %	Observed	Predicted	Error %
1	Aligarh	3712	3603	3.7	3691	3495	6.8
2	Meerut	4216	4059	4.7	4254	3964	7.4
3	Saharanpur	3521	3171	9.9	3421	3085	9.8
4	Bijnor	2703	3197	3.9	2889	3281	2.1
5	Moradabad	2830	3131	-1.81	2997	3336	-1.31
6	Pilibhit	3871	3818	-10.2	3759	3872	-10.6
7	Rampur	3316	3042	1.3	3357	3279	-3.0
8	Bareilly	3672	3527	8.2	3704	3624	2.3
9	Muzaffarnagar	3809	3627	2.9	3612	3343	5.2
10	Badun	3768	3465	8.00	3747	3419	8.71

value ranged between 0.26 to 0.87 in different districts which were significant at P = 0.5. Similar to the wheat crop the minimum temperature was common contributing factors in models for mustard crop in most of the districts under study. During validation period 2014 and 2015 the performance of models were quite satisfactory as the percent errors were less than 10 in all districts(Table 5).Hence these models can be used to forecast mustard yield in the districts under study.

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Table 4: Pre-harvest yield forecast model (F3 stage) of Mustard crop for different districts of Western Uttar Pradesh

S.No.	District	Equation	R^2	F	Std error
1	Aligarh	Y=849.649+ (32.12 * time)	0.50	20.03	213.57
2	Budaun	Y=260.92+(39.85*Z11)+(.12*Z241)	0.40	13.62	81.32
3	Bulandshar	Y=1190.9+(10.8*time)+(0.5*Z121)+(38.5*Z11)	0.67	40.75	106.42
4	Moradabad	Y=-861.26+(.08*Z141)+(2.69*Z121)+(-53.34*Z21)	0.87	66.4	138.4
5	Rampur	Y=1805.3+(.71*Z121)	0.43	15.2	97.30
6	Shahjanpur	Y=1056.6+(171.8*Z11)+(.07*Z451)+(.02*Z340)	0.26	7.10	130.16

Table 5: Observed and forecasted ($kgha^{-1}$) yield of mustard crop in 2014 and 2015 for various districts of western Uttar Pradesh

		2014			2015		
S.No.	Districts	Observed	Predicted	Error %	Observed	Predicted	Error %
1	Aligarh	1455	4588	-9.0	1597	1621	-1.4
2	Budaun	611	616	1.5	590	598	4.8
3	Bulandshar	1376	1258	8.7	1319	1217	9.8
4	Moradabad	1153	1164	-1.0	1076	1212	-1.2
5	Rampur	1132	1029	9.0	1046	1055	8.4
6	Shahjanpur	908	902	0.6	971	930	1.6

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