Environmental Assessment for Phenotyping Network

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Introduction

To assess performance of genotypes, crop improvement programs need to evaluate materials under different environmental conditions. Testing programs can be more efficient if they can select testing sites that permit evaluation over a broad range of environments. What methods and tools can be used to select such testing sites? We use agronomic and environmental modeling: Conditions at more than fifty candidate testing sites were evaluated using data on climate, soils, crop production and other variables. For each candidate site, climate information was used to characterize water balance, seasonal variation in rainfall, evapotranspiration, temperature and length of the growing season. Crop production, soil characteristics and climatic conditions for each candidate site were derived from digital maps using overlay techniques. A set of existing climate analysis tools and a research atlas have been adapted and modified for use by GCP researchers. The information derived from this study will be used to support decisions on the deployment and testing of genotypes in crop improvement programs

Climate Analysis for prospective phenotyping trial sites

1. Data Collection

Out of almost 30,000 climatologic stations worldwide, New_LocClim uses the nearest 10 neighboring stations to interpolate for each user-provided location (FAO, 2005).

2. Data Processing

- *2.1 Reference Evapotranspiration (ETo)*
- *2.2 Rainfall*
- *2.3 Length of growing period*
- *2.4 Aridity Index*
- *2.5 Day length and sunshine hours*
- *2.6 Mean, maximum and minimum temperature*
- *2.7 Solar, photosynthetically active and net radiation*

Bambey, Senegal (14.71° N, 16.48° W; 19 m AMSL) Summary of Agro-climatic data analysis

Total Annual ETo (mm)	Total Annual Rainfall (mm)	Aridity Index
2112.3	514	0.24 (Semi-Arid)

Total length of growing period (days)	Growing period 1		Growing period 2	
	Start	End	Start	End
90	11-Jul	8-Oct	-9999	-9999

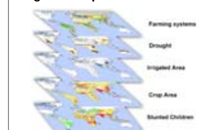
Mean Daylength (h)	Mean Sunshine hours (h)
12.10	8.04

Indicators	Growing period	Off-growing Period
Length (days)	90	275
Rainfall (mm)	427	87
ETo (mm)	416	1696
Mean Temperature (°C)	28	26
Maximum Temperature (°C)	33	35
Minimum Temperature (°C)	22	17
Solar Radiation(MJ/m²)	1728	5706
PAR(MJ/m²)	864	2853
Net Radiation (MJ/m²)	1064	3136

GCP Research Atlas

Agricultural information includes maps of key GCP crops from IFPRI's SPAM – Spatial Allocation Model (You and Wood, 2006).

The Atlas contains phenotyping candidate sites, crop production data, climate matching maps, soil constraints information, an irrigation map and others.

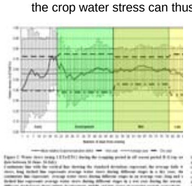


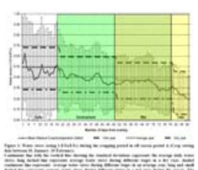
Phenotyping candidate sites and other geographic information will be made available in Google Earth

Crop water stress

The estimation of water stress at different crop stages and their effect on total crop productivity help to determine the best crop variety for different situations. The simulation of the soil water balance is an efficient way to estimate the crop water stress during the growing season.

The soil water content in the root zone is simulated using the BUDGET simulation model (Raes et. al. 2006a). By keeping track of the incoming and outgoing water at the boundaries of the root zone, the water retained in the root zone can be calculated at the any moment of the season by means of the BUDGET model. The actual evapotranspiration to calculate the crop water stress can thus be determined.





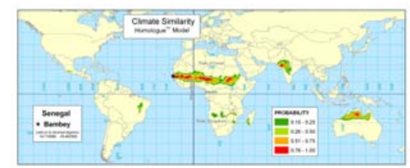
Spatial Analysis

Buffer zones used to characterize experimental sites

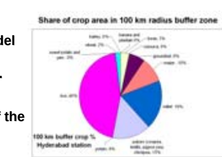
Selection of experimental sites considers crops, soils, climate and socioeconomic conditions in the surrounding area. An overlay analysis was developed to assess these conditions in buffers of 50 and 100 km radius from each site.

Name	cassava	maize	pulses	rice	wheat	total
Awasa	0	265	0	0	110	375
Bamako/Segou (Cinzana Station)	0	62	111	160	0	333
Bambey	27	38	136	32	0	234
Bangalore	27	203	687	796	2	1,716
Beijing(Changping)	4	950	19	105	1,135	2,213
Cali	15	57	0	131	0	204
Chiredzi	92	562	0	3	6	662
Chitedze	101	934	235	21	2	1,293
Chokwe	141	376	0	4	46	567
Coimbatore TNAU	143	213	339	888	0	1,584
Dharwad, UAS, DWR	0	379	499	706	240	1,825
Faizabad (NDUAT)	0	558	602	3,269	3,576	8,005
Guyuan of Ninxia University	6	365	19	6	672	1,068
Hazaribag, Jharkhand ICAR	0	238	437	3,293	650	4,618
Hengshui of Hebei Province	7	2,704	41	171	2,103	5,026
Hissar Haryana Ag Univ.	0	52	306	2,237	4,639	7,234
Hyderabad, Barwale Foundation	0	18	9	119	4	150
Hyderabad, Rajendranagar NRCS	9	332	520	1,560	64	2,485
Ikenne	443	717	26	87	0	1,273
IRRI	9	81	0	900	0	990
Janauba	22	97	0	17	0	135
Kano, Minjibir	25	435	1,341	189	5	1,994
Karnal	0	366	285	2,356	5,126	8,132
Kiboko	23	625	151	16	12	827
Lanzhou, Gansuo University	3	84	9	1	403	500
Luoyang of Henan province	0	1	0	0	2	3
Luoyang, Luoyang Academy	10	877	29	250	1,356	2,522
Nazret	0	80	18	0	209	307
Niamey	5	102	769	10	2	888
Nyankpala	55	177	73	59	0	364
Obregon Valle del Yaqui	0	18	1	0	250	269
Patancheru	9	341	530	1,435	79	2,394
Porangatu	4	153	0	49	0	206
Pune	0	92	493	437	385	1,407
Raipur IGAU	0	60	598	3,236	200	4,093
Shijiazhuang City	7	1,614	33	115	1,374	3,143
Tak Fa	322	349	0	3,379	0	4,050
Teresina	25	114	0	169	0	308
Tlaltizapan	0	904	14	4	63	987
Turrialba	8	23	0	88	0	119
Ubon Ratchathani	267	398	0	3,382	0	4,047
Urumqi of Xinjiang	1	35	1	5	92	134
Yangling (Xian) of Shaanxi	7	603	33	142	707	1,493
Yinchuan of Ninxia	0	101	6	63	250	421
Yuncheng of Shanxi Province	6	663	27	124	642	1,461

This table shows the area in hectares of key GCP crops in a buffer of 100 km radius around each proposed trial site.



Climate homologues for each proposed experimental site support genotype testing and deployment decisions. This model considers climate and soil conditions of the site of interest.

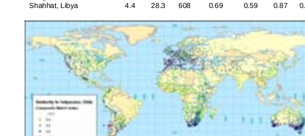


The proportional share of the total area of GCP crops around the Hyderabad experiment station in India

Climatic similarity between stations

The table and figure below show the results of a climate similarity analysis among Valpariso, Chile, and four other stations in Mediterranean climates. Included are stations with some of the highest similarity indices in the USA, Australia, and the northern and southern extremes of Africa. Temperature and rainfall values are shown together with the similarity indices calculated using CLIMEX software. The composite match index (CMI) combines six climate parameters. The corresponding map shows the CMI's for over 2000 weather stations throughout the world. Higher CMI values indicate greater similarity.

Location	Tmin	Tmax	Rtot	I-Tmin	I-Tmax	I-Rtot	CMI
Valparaiso, Chile	8.3	22.2	506	1.00	1.00	1.00	1.00
Kingscote, Australia	8.2	24.8	485	0.87	0.86	0.97	0.88
San Francisco, USA	7.2	20.6	463	0.90	0.75	0.92	0.87
Wingfield, South Africa	7.2	26.1	509	0.82	0.68	0.99	0.86
Shahhat, Libya	4.4	28.3	608	0.69	0.59	0.87	0.79



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Acknowledgments

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For further information

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http://sites.google.com/a/cgiar.org/environmental-assessment-for-phenotyping-network/Home).