



GxE Field Experiment 2022 SOP

Visit the GxE website for the latest SOP and information updates:

www.genomes2fields.org

About this document:

Our goal is to collect the most “raw” and meaningful data possible, to be collated in a centralized database and shared with the public. Raw data will give us the most power to analyze and leverage insights from the data. It is a difficult and time-consuming task to assimilate all this information into one place in a consistent format. Therefore, we ask that you pay close attention to the form of data types collected in terms of units, formatting, etc.

Please note that multiple people now collectively serve as and fulfill the needs of the G2F Coordinator position. Please direct any inquiries to g2f@wisc.edu.

Lastly, we would like to thank you, our cooperators, for your monumental efforts and unprecedented collaborative spirit. Without you, the Genomes to Fields GxE Project would not be possible.

Thank you!

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Contact the G2F team at g2f@wisc.edu with any questions.

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GxE Field Experiment 2022 Checklist

Preseason:

For new cooperators only:

_____ Email Natalia de Leon at ndeleongatti@wisc.edu to get started

For all cooperators (including new):

_____ Order weather station components with assistance of Iowa Corn Promotion Board (David Ertl at dertl@iowacorn.org)

_____ Communicate seed packaging and shipping requirements with Natalia de Leon (ndeleongatti@wisc.edu) and the g2f Team (g2f@wisc.edu)

_____ Perform [annual maintenance](#) on weather station and clear existing data

_____ Begin work on Google Sheets location folder through your personalized link

At Planting:

_____ Install weather station in field (ideally one day before planting, if possible)

_____ Ensure external instruments are in correct port:
(soil moisture - port A, soil temperature - port B, solar radiation - port C)

_____ Collect and record the GPS coordinates of weather station

_____ Collect weather station serial number [m2700s0XXXX] on card inside weather station

_____ Perform weather station [setup tasks](#) and activate weather station recording

_____ Collect soil sample and send to Ward Laboratories in Kearney, NE ([Appendix B](#))

_____ Record planting date in fieldbook provided through your personalized link

_____ Update Google Sheets metadata with:

_____ Weather station serial number and GPS coordinates

_____ Date weather station was placed in the field

_____ GPS coordinates of field corners, starting at corner of plot 1

In-Season:

_____ Create and upload field map to Google folder. Notify Natalia (ndeleongatti@wisc.edu), of any field/planting issues or adjustments to original field map

_____ Perform [weather station in-season checks](#) at each field visit. Download data monthly, if possible

_____ Record the following phenotypic data in the fieldbook:

_____ Flowering dates

_____ Plant height

_____ Ear height

_____ If damaging winds occur, cooperators may choose to record green snap and date of event

_____ Stand count

_____ Record the following field information in the Google Sheets agronomic information:

_____ Pesticides and herbicides: type and amount applied

_____ Fertilizer: date, type, and amount applied

_____ Irrigation schedule: date and amount applied (if applicable)

_____ Fertigation schedule: date and amount applied (if applicable)

_____ Notes on field anomalies, phenotyping errors and any other issues

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At Harvest:

_____ Record the following performance data in the fieldbook:

_____ Root lodging

_____ Stalk lodging

_____ Plot weight

_____ Plot moisture

_____ Test weight

Post-Season:

_____ Verify information in Google Sheets metadata

_____ Upload final field information, phenotype, and performance data to Google Sheet

_____ Download weather station data and upload unedited SWD files to Google folder

I. Field Layout for 2022 and 2023 seasons

- a. Each trial is arranged in two or three replications (number of plots depending on the location, with three reps occurring only at locations with more than 1000 total plots). For the purposes of blocking in the field, the primary division is by replication (1, 2, or 3).
- b. Additional experiments were created upon request for external Yellow Stripe to facilitate additional phenotyping. External experiments with two replications of 22 entries were also created upon request for Hybrid HIPS and Inbreed HIPS.
- c. The objective of the experimental design was to balance the need for within-site replication against the overall goal of the GxE project to test as many different hybrids as possible at each trial site.
- d. Within an experiment there are two or three replications, and each replication will have one plot of each of the 31 core check hybrids based on seed availability. A sample of at least 25 of the experimental hybrids is also replicated within each location (with a different sample replicated at each environment). The remaining plots are occupied by hybrids that occur in only a single replication within the environment. Finally, entries were assigned to incomplete blocks of 10 or 20 plots each within each replication. This represents a combination of features of incomplete block designs, augmented designs, and partially replicated designs. D-efficiency was optimized at each level of sampling in the design (selection of hybrids among environments, assignment to replications within environments, and assignment to incomplete blocks within replications) to maximize balance under the restrictions of variably limited seed availability for some hybrids.
- e. Most hybrid trials are arranged in two-row plots, 20' long with 30-72" alleys between plots. Filler should be used as needed to minimize edge effects.
- f. The diagram on the following page represents the ideal setup with plot numbers (500 plots experiment). Departures from this specific layout are completely acceptable.
- g. Each investigator is asked to choose one locally adapted hybrid to add as checks to each trial to increase connection among trials within a location. Ideally, this check will be replicated twice for 4 plots. Empty seed packets are provided for collaborators to fill. Investigators in similar areas are encouraged to choose one or more of the same common checks for connecting sets to provide additional connection among experiments and locations.
- h. Planting density and plot dimensions are determined by individual collaborators and reported in the Metadata in the Google Sheet.

For suggested field layouts, see the following page (page 6).

Row#	24 Row Example												20'
	FILLER				500	499	498	497	496	495	494	493	
REP 2	481	482	483	484	485	486	487	488	489	490	491	492	20'
	480	479	478	477	476	475	474	473	472	471	470	469	20'
	457	458	459	460	461	462	463	464	465	466	467	468	20'
	456	455	454	453	452	451	450	449	448	447	446	445	20'
	433	434	435	436	437	438	439	440	441	442	443	444	20'
	432	431	430	429	428	427	426	425	424	423	422	421	20'
	409	410	411	412	413	414	415	416	417	418	419	420	20'
	408	407	406	405	404	403	402	401	400	399	398	397	20'
	385	386	387	388	389	390	391	392	393	394	395	396	20'
	384	383	382	381	380	379	378	377	376	375	374	373	20'
	361	362	363	364	365	366	367	368	369	370	371	372	20'
	360	359	358	357	356	355	354	353	352	351	350	349	20'
	337	338	339	340	341	342	343	344	345	346	347	348	20'
	336	335	334	333	332	331	330	329	328	327	326	325	20'
	313	314	315	316	317	318	319	320	321	322	323	324	20'
	312	311	310	309	308	307	306	305	304	303	302	301	20'
	289	290	291	292	293	294	295	296	297	298	299	300	20'
	288	287	286	285	284	283	282	281	280	279	278	277	20'
	265	266	267	268	269	270	271	272	273	274	275	276	20'
	264	263	262	261	260	259	258	257	256	255	254	253	20'
REP 1	241	242	243	244	245	246	247	248	249	250	251	252	20'
	240	239	238	237	236	235	234	233	232	231	230	229	20'
	217	218	219	220	221	222	223	224	225	226	227	228	20'
	216	215	214	213	212	211	210	209	208	207	206	205	20'
	193	194	195	196	197	198	199	200	201	202	203	204	20'
	192	191	190	189	188	187	186	185	184	183	182	181	20'
	169	170	171	172	173	174	175	176	177	178	179	180	20'
	168	167	166	165	164	163	162	161	160	159	158	157	20'
	145	146	147	148	149	150	151	152	153	154	155	156	20'
	144	143	142	141	140	139	138	137	136	135	134	133	20'
	121	122	123	124	125	126	127	128	129	130	131	132	20'
	120	119	118	117	116	115	114	113	112	111	110	109	20'
	97	98	99	100	101	102	103	104	105	106	107	108	20'
	96	95	94	93	92	91	90	89	88	87	86	85	20'
	73	74	75	76	77	78	79	80	81	82	83	84	20'
	72	71	70	69	68	67	66	65	64	63	62	61	20'
	49	50	51	52	53	54	55	56	57	58	59	60	20'
	48	47	46	45	44	43	42	41	40	39	38	37	20'
	25	26	27	28	29	30	31	32	33	34	35	36	20'
	24	23	22	21	20	19	18	17	16	15	14	13	20'
	1	2	3	4	5	6	7	8	9	10	11	12	20'
Row#	1	3	5	7	9	11	13	15	17	19	21	23	

50 Row Example																									
REP 2																									
500	499	498	497	496	495	494	493	492	491	490	489	488	487	486	485	484	483	482	481	480	479	478	477	476	20'
451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	20'
450	449	448	447	446	445	444	443	442	441	440	439	438	437	436	435	434	433	432	431	430	429	428	427	426	20'
401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	20'
400	399	398	397	396	395	394	393	392	391	390	389	388	387	386	385	384	383	382	381	380	379	378	377	376	20'
351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	20'
350	349	348	347	346	345	344	343	342	341	340	339	338	337	336	335	334	333	332	331	330	329	328	327	326	20'
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	20'
300	299	298	297	296	295	294	293	292	291	290	289	288	287	286	285	284	283	282	281	280	279	278	277	276	20'
251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	20'
REP 1																									
250	249	248	247	246	245	244	243	242	241	240	239	238	237	236	235	234	233	232	231	230	229	228	227	226	20'
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	20'
200	199	198	197	196	195	194	193	192	191	190	189	188	187	186	185	184	183	182	181	180	179	178	177	176	20'
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	20'
150	149	148	147	146	145	144	143	142	141	140	139	138	137	136	135	134	133	132	131	130	129	128	127	126	20'
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	20'
100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	20'
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	20'
50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	20'
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	20'

II. WatchDog 2700 Weather Station Configuration

- a. For investigators with multiple GxE trial fields, weather stations should be located within ¼ mile of all trial fields. For trials > ¼ mile apart, or for trials with varying water treatments, request a second micro weather station to measure soil moisture differences.
- b. In order to maintain consistency and adhere to meteorological measurement standards, the weather station should be placed at a height of 2 meters (~6 ft). Purchase a 1 ⅜" wide x 10' 6" long top rail fence post similar to one found here: <https://goo.gl/40KoTW>. This will replace the 3 ft. post that comes with the tripod. Cut the post at the non-tapered end so you're left with 7 ft.
- c. Complete annual maintenance prior to the field season using checklist in [Appendix C Part A](#)
- d. Complete weather station setup the day before planting, using checklist in [Appendix C Part B](#)
- e. Throughout the field season, use [Appendix C Part C](#) to conduct weather station checks at each field visit. Record date and time of check in on location-specific Google Sheet
- f. Record irrigation amounts and dates in on location-specific Google Sheet
- g. Remove the station from the field after harvest using instructions in [Appendix C Part D](#)
- h. Collect data and upload to Google Sheets using [Appendix C Part E](#)

III. Seed Information

- a. Hybrid seed will be sent to most collaborators (excluding Southern locations) in early April. All seed has been chemically treated with Cruiser Extreme 250.

IV. Field Metadata Collection:

Collaborators will record the following metadata in the appropriate location on a location-specific Google Sheet through the link that was shared.

At Planting:

- i. Planting dates [MM/DD/YY]
- ii. Collect soil sample for basic analysis at Ward Laboratories. See Appendix B for detailed instructions.
- iii. Weather station serial number [m2700s0XXXX]
- iv. Latitude/longitude (GPS coordinates) of field location
- v. Row spacing and plot dimensions
- vi. Map of field layout with cardinal heading of first pass (i.e. the direction of pass 1 looking toward the end of the field). Need help figuring out cardinal direction? Visit <http://acscdg.com/>. Locate your field, draw a line from plot 1 parallel with rows and record Azimuth number.
- vii. Local hybrid checks
- viii. Previous crop
- ix. Tillage method
- x. Weather station documents irrigation? (if applicable) [Y/N]
- xi. Notes on planting errors, field anomalies, equipment, etc.

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In-Season:

- xii. Pesticides and herbicides: type and amount applied
- xiii. Fertilizer: date, type, and amount applied
- xiv. Irrigation schedule: date and amount applied (if applicable)
- xv. Fertigation schedule: date and amount applied (if applicable)
- xvi. Notes on field anomalies, phenotyping errors and issues

At Harvest:

- xvii. Harvest dates [MM/DD/YY]
- xviii. Notes on field anomalies, whole-field issues, equipment and technical issues, or harvesting issues

V. Phenotype and Performance Data Collection:

Evaluate hybrids for the following traits. See [Appendix A](#) for specific measurement instructions.

In-Season:

- i. Stand Count - may be taken as juveniles and at harvest
- ii. Anthesis [MM/DD/YY]
- iii. Silking [MM/DD/YY]
- iv. Plant Height (cm)
- v. Ear Height (cm)
- vi. If damaging winds occur, cooperators may choose to record green snap and date of event

At Harvest:

- vii. Stalk Lodging – plant count (NOT percentage)
- viii. Root Lodging – plant count (NOT percentage)
- ix. Stand Count – plant count
- x. Plot Weight (lbs)
- xi. Grain Moisture (%)
- xii. Test Weight (lbs/bu)

Appendix A: Phenotyping Handbook

Trait Summary					
Trait	Abbreviation	Unit	Timing	Description/Procedure	Measurement Notes
Pollen Date (Anthesis)		date [MM/DD/YY]	at flowering	Date that 50% of plants in the plot began shedding pollen.	
Silk Date (Silking)		date [MM/DD/YY]	at flowering	Date that 50% of plants in the plot had visible silks.	
Ear Height	EARHT	centimeter [cm]	plant maturity	Height to node of attachment of the ear.	One plant is considered sufficient since these are hybrids and are not segregating for traits
Plant Height	PLTHT	centimeter [cm]	plant maturity	Height to attachment of flag leaf.	One plant is considered sufficient since these are hybrids and are not segregating for traits
Root Lodging	RTLDTG	count [number]	before harvest	Number of plants root lodged i.e. those stems that lean substantially to one side (> 15% from vertical). Count includes goosenecked plant that have "straightened up" after becoming lodged earlier in the season.	Emphasis is on the number of plants.
Stalk Lodging	SKLDG	count [number]	before harvest	Number of plants root lodged.	Emphasis is on the number of plants.
Stand Count	STAND	count [number]	before/at harvest	Number of plants in the plot.	Number of plants were in the plot at harvest time. Counting can occur earlier but if plot damage occurs before harvest the plot will need to be recounted.
Green Snap (optional)	GSP	count and date of causal event [MM/DD/YY]	before flowering	Number of plants broken between ground level and top ear node before flowering.	Optional, cooperators may record this if an event causes substantial green snap
Plot Weight	WT	lbs [number.decimal]	at harvest	Weight of harvested grain.	
Test Weight	TWT	lbs/bu [number.decimal]	at harvest	Grain density.	
Grain Moisture	MOIST	percent [%]	at harvest	Percent moisture content of harvested grain.	

Pollen Date (Anthesis)

Description/Procedure:

Taken as [MM/DD/YY] to 50 percent of a plot exhibiting anther exertion on greater than half of main tassel spike. Day of anthesis recording is shown in *Picture 1*, whereas the day after is shown *Picture 2*.

Timing: At flowering

n = 1 date per plot

Unit: [MM/DD/YY]



Picture 1



Picture 2

Image Credit: 2004, 2006; Purdue University, RL Nielsen

Silk Date (Silking)

Description/Procedure:

Taken as [MM/DD/YY] to 50 percent of plot exhibiting silk emergence (*Picture 1*). Following day is shown in *Picture 2*.

Timing: At Flowering

n = 1 date per plot

Unit: [MM/DD/YY]



Picture 1



Picture 2

Visit www.genomes2fields.org for the latest SOP and information updates.

Contact the G2F team at g2f@wisc.edu with any questions.

Ear Height (EARHT)

Description/Procedure:

Placing measuring stick on ground next to the root crown, “ear height” is measured at the primary ear bearing node.

Timing: At plant maturity

n = 1 representative plant per plot

Unit: centimeter [cm]

Notes: One plant is considered sufficient since these are inbreds and hybrids and are not segregating for traits.



Plant Height (PLTHT)

Description/Procedure:

Placing measuring stick on ground next to the root crown, “plant height” is measured at the ligule of the flag leaf.

Timing: At plant maturity

n = 1 representative plant per plot

Unit: centimeter [cm]

Notes: One plant is considered sufficient since these are inbreds and hybrids and are not segregating for traits. Please record date measured.



Root Lodging (RTLDDG)

Description/Procedure:

Number of plants that show root lodging per plot, i.e., those stems that lean substantially to one side ($\geq 15\%$ from vertical) (*Picture 2*). Count includes “goosenecked” plants that have “straightened up” after becoming lodged earlier in the season (*Picture 1*).

Timing: Before Harvest

n = 1 count per plot

Unit: number of plants with RLD

Notes: Emphasis is on the number of plants, not the %. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses.



Picture 1



Picture 2

Stalk Lodging (SKLDG)

Description/Procedure:

Number of plants broken between the ground level and the top ear node.

Timing: Before Harvest

n = 1 count per plot

Unit: number of plants with SLD

Notes: Emphasis is on the number of plants, not the %, which does not tell us much. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses.



Image credit: Gordon Johnson, UDel Extension

Green Snap (GSP) (optional)

Description/Procedure:

Number of plants broken between the ground level and the top ear node **before flowering**.

Timing: Before flowering

n = 1 count per plot

Unit: number of plants with GSP and date of triggering event [MM/DD/YY]

Notes: Collaborators may choose to take counts of green snap following a weather event occurring before flowering that causes substantial numbers of stalks to snap. Please also record date of event.

Emphasis is on the number of plants, not the %, which does not tell us much. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses.



Image credit: UGA Cooperative Extension

Stand Count (STAND)

Description/Procedure:

Number of plants per plot at harvest.

Timing: at harvest

n = 1 count per plot.

Unit: count

Notes: Main consideration is how many plants were in the plot at harvest time. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses. Counting can occur earlier but if a plot damage occurs before harvest they will need to be recounted.

Plot Weight (WT)

Description/Procedure:

Shelled grain weight per plot

Timing: At Harvest

n = 1 weight per plot

Unit: lbs

Test Weight (TWT)

Description/Procedure:

Shelled grain weight per bushel

Timing: At Harvest

n = 1 weight per plot

Unit: lbs/bu

Grain Moisture (MOIST)

Description/Procedure:

Water content in grain at harvest.

Timing: At Harvest

n = 1 measure per plot

Unit: percent [%]

Appendix B: Soil Sampling Handbook

a. Soil Sampling Instructions for GxE 2022

1. Each sample should be made up of a minimum of **10 cores** to ensure accurate representation of the field, ideally 20 or more cores. Cores should be taken to a depth of 30cm.
2. For uniform fields: When gathering soil cores to make a composite sample, collect cores in a uniform pattern over the whole trial area.
3. For fields with known clines/variants: Sample in order to get an accurate representation of the majority of the field. If significant differences exist in areas of the field, sample areas separately and submit multiple, clearly labeled samples.
4. Thoroughly mix the cores before placing approximately 2 cups in the sample bag. This can be a sample bag, or a regular Ziploc bag.
5. Label the bag with PI name and experiment name.
6. Complete a [sample submittal form](#).
7. Secure samples for shipping and send to:
Ward Laboratories, Inc.
4007 Cherry Ave, PO Box 788
Kearney, Nebraska 68848-0788
(308) 234-2418 Fax (308) 234-1940
www.wardlab.com

Use UW Madison Agronomy UPS Account: 55W1X6

8. **SOIL SAMPLES FROM REGULATED/FOREIGN AREAS (TX, GA, GE, ON, NC, SC):** All samples need to be shipped in sturdy, leak proof containers which preclude spillage or pest escape in transit and while awaiting processing. Sealed tubes, vials or cans placed in sealed coolers or sturdy boxes are acceptable shipping containers. Use the account # above. All samples need to have a copy of the Soil Permit inside and affixed to the outside. For foreign soils, a copy of [PPQ Form 330](#) goes on the outside of the box.

This requirement applies to samples from **TX, GA, NC, SC, Ontario and Germany**.

Appendix C: Additional Weather Station Resources

For weather station issues, contact:

Hardware:
David Ertl
dertl@iowacorn.org

515-225-9242

Software/Technical Support:
Octavio Valle
ovalle@specmeters.com

815-436-4440 (mention Iowa Corn), or
800-248-8873 and ask for Terri or Tech Support

a. Annual Watchdog 2700 Pre-Season Tasks

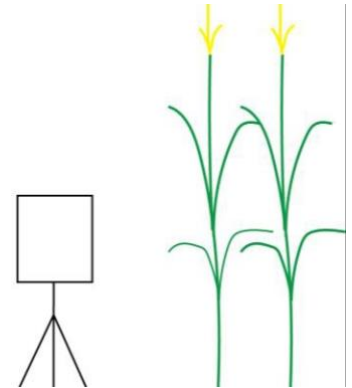
- i. Check that all sensors are reading correctly on LCD screen. See item (f) for specific instructions regarding the calibration/troubleshooting of individual instruments.
- ii. Rearrange the external instruments to the following ports:
 1. Soil moisture - Port A
 2. Soil temperature - Port B
 3. Solar radiation - Port C
 4. PAR sensor - Port D
- iii. Using the SpecWare software with the station connected, delete the data from the logger (Logger > WatchDog Manager > Advanced > Clear > OK)
- iv. Using the SpecWare software with the station connected, turn off unused ports and verify instrument port location (Logger > WatchDog Manager > Properties > uncheck Enabled box for unused ports and correct Sensor/Units > OK)
- v. Replace batteries - 4 AA.
- vi. Check for inhibitors or damage to the sensors:
 1. Waste in rain gauge
 2. Damaged sensor wires
 3. Damaged external parts
 4. Dirt on sensors
- vii. Inspect fasteners and ensure all are tight.
- viii. Check for moisture damage & corrosion. Inspect circuit board if there are signs of water damage or corrosion.

b. WatchDog 2700 Field Setup

Use the following checklist to complete setup of the weather station

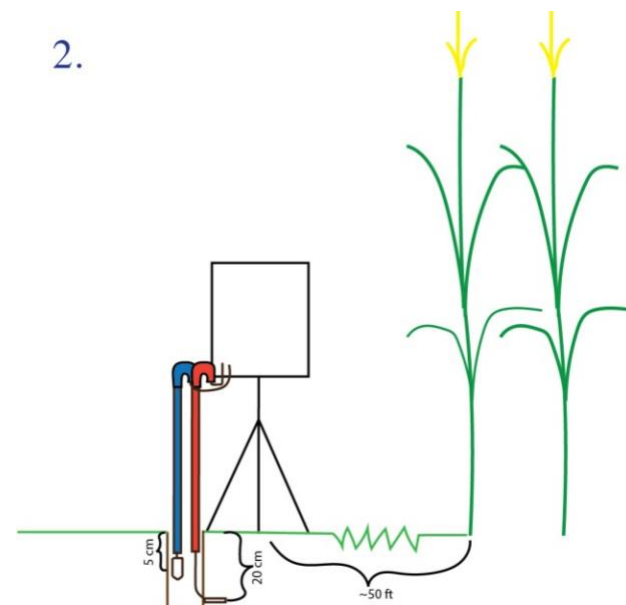
Station Placement:

- _____ Place the weather station at the edge of GxE field trial on level ground so that there are no shadows from the corn or other obstructions hitting the station, approximately 6 to 10 feet away from the corn if possible.
- _____ Drive the tapered end of the 7 ft post 1 ft into the ground
- _____ Secure the tripod around the post
- _____ Secure the feet of the tripod
- _____ Secure the weather station on top of the tripod with the front facing south
- _____ Point the wind vane and anemometer away from the rest of the station
- _____ Use a compass to point the nose of the wind vane to North. Hit Display > Set > Set North > Set > Set to calibrate.
- _____ Install rain bucket cover by bending legs of hardware cloth and inserting into bucket
- _____ Check the date and time
- _____ Set the logging interval to 30 minutes
- _____ Clearly mark weather station location for passing farm equipment



Soil Temperature Sensor and Cable Protector:

- _____ Use a small shovel to dig a trench that is 20 cm (~8 in) deep and 15-18 cm (6-7 in) wide (see 2).
- _____ Insert the soil temperature sensor horizontally into the wall at the bottom of the trench. If the soil is too dense make a small indentation (e.g. end of screwdriver) in the soil to get it started. Watch video for a demonstration. <https://youtu.be/ZXpel7ukEW8>
- _____ Lightly tamp the soil around the sensor to ensure complete contact
- _____ Feed the sensor cable through the shaft and rain head of the red cable protector
- _____ Place the shaft vertically in the soil
- _____ Tamp the soil around the shaft to provide vertical support (The pipe [not the sensor] can be deeper than 20 cm (~8 in) in the soil)
- _____ Use the cable tie to fasten the cable protector to the tripod leg, stick or rod with a cable tie
- _____ Use a cable tie to secure extra cable off of the ground
- _____ Plug the sensor lead into port "B" on the weather station
- _____ Replace and *lightly compact* the soil until the trench is 5 cm (~2 in) deep



Soil Moisture Sensor and Cable Protector:

- _____ Place the [soil moisture sensor](#) into the [blue end of the shaft](#) with the remaining cable pushed through the rain head. The shoulder of the sensor will rest on the cut face of the shaft. Make sure the sensor does not align with the slit in the end of the shaft (see 2)

- _____ Loosen the soil using a soil probe to make a hole to insert the probe. Refill the hole with loose soil. Push the sensor gently into the soil so the top of the sensor is even with the soil in the trench. **DO NOT** push hard, the sensor is breakable!! Watch this video for a demonstration.
<https://youtu.be/ZXpeI7ukEW8>
- _____ Tamp the remaining soil around the outside of the shaft to divert surface water and support the shaft.
- _____ Use a cable tie to secure extra cable off the ground
- _____ Plug the sensor into port “A” on the weather station

c. In-Field WatchDog 2700 Maintenance

Weather station checks should take place at each field visit. Note the date and time of station check in metadata sheet to allow proper data cleaning.

Anemometer:

- _____ Clean dirt/debris from the wind cups
- _____ Check display values to ensure the sensor is still working (Display > Current > Current > Up Arrow)
- _____ Ensure the cups still spin freely

Wind vane:

- _____ Clean dirt/debris from the wind vane
- _____ Check display values to ensure the sensor is still working (Display > Current > Current > Up Arrow)

Rain bucket:

- _____ Remove debris from the top of the bucket, both on and beneath hardware cloth cover
- _____ Unscrew the top and lift lid
- _____ Remove dirt/debris from inside the bucket
- _____ Set the display to view rain values (Display > Current > Current > Up Arrow > Down Arrow) and tip the bucket to ensure the sensor is still working
- _____ Replace the lid and cover for rain bucket

Solar radiation sensor:

- _____ Remove dirt/debris from the solar radiation sensor
- _____ Check display values to ensure the sensor is still working properly (Display > Current > Current > Up Arrow (x8 for Port C))

Soil temperature sensor:

- _____ Check display values to ensure the sensor is still working properly (Display > Current > Current > Up Arrow (x7 for Port A))

Soil moisture sensor:

- _____ Check display values to ensure the sensor is still working properly (Display > Current > Current > Up Arrow (x6 for Port A))

All cables:

- _____ Check all sensor cables for exposed wires/breakages

d. Post-Field Season WatchDog 2700 Removal

After the field is harvested, the weather station should be carefully removed to increase longevity.

- _____ Unplug the soil temperature and soil moisture sensors from the weather station
- _____ Remove the soil temperature and soil moisture sensors by carefully digging them out with a shovel
- _____ Replace the soil for the trench
- _____ Clean soil from the cable protectors and fold up sensor cables taking care to avoid sharp bends
- _____ Take down the weather station
- _____ Remove the 7 ft post from the soil and remove packed soil from the end

Transferring SWD files / data

To transfer files, i.e., to consolidate data from multiple locations and computers, you can download your WatchDog weather station data and upload it to CyVerse by doing the following:

- i. Connect the weather station to the computer and open SpecWare to transfer data
- ii. Select Logger > Get WatchDog 1000/2000 Data
- iii. Navigate to your SpecWare folder on the C-drive
- iv. Open the folder for the desired station
- v. Select all .SWD files and upload to the Weather folder using the location-specific Google Sheet link that was shared

e. Additional Links to Resources:

1. Software Setup: SpecWare9 Quick Start Guide
2. Complete Watchdog Weather Station Manual
3. Additional Spectrum Technology manuals

f. WatchDog Troubleshooting and Calibration Methods

To test the weather station, press the “Display” button to turn on the display. Press the “Current/Archive” button until the display reads “Current Values”. Then use the arrow keys to step through the various instrument readings and test the output. Please wait up to 30 seconds for the display to update the current conditions.



- i. Anemometer:
 1. If wind speed constantly or intermittently reads zero
 - a. Ensure the anemometer is fully plugged in
 - b. Check for broken wires along the cable especially where the cable is secured
 2. If anemometer (wind cups) does not spin freely
 - a. Use a 0.05" allen wrench (should have been included with station) to loosen screw and drop the cups slightly (approx. 1/16")
 - b. Check wind speed output to determine if it is reasonable. If the speed seems too fast, tighten the screw. If the speed seems too slow, loosen the screw.
- ii. Wind vane:
 1. If the wind direction does not update after the wind vane is moved
 - a. Ensure the wind vane is fully plugged in
 - b. Check for broken wires along the cable especially where the cable is secured
 2. If the wind direction on display does not match true direction
 - a. Using a compass (or smart phone app) point the nose of the wind vane to the north
 - b. Turn on the weather station display by pressing the "Display" button
 - c. Hit the "Set" button
 - d. Use the arrows until the display reads "Set North" then push "Set"
 - e. Point the nose of the wind vane to north and press "Set" again. The weather station will calibrate north and return to the "Current" display
- iii. Rain bucket:
 1. If the rain bucket is not collecting data when the bucket is tipped
 - a. Loosen 4 screws at base of rain bucket twist the black bucket to the right about ½", and lift lid
 - b. Remove dirt or debris that could be preventing the bucket from tipping
 - c. Manually move the bucket back and forth several times. Each tip is one one-hundredth of an inch (or 0.254 millimeters).
 - d. Check the display to determine if the proper amount of rain was recorded
 2. If the LCD is not showing any or all of the manual tips of the spoon
 - a. The magnetic sensor on the tipping spoon may be too far from the read switch or the sensor cable is bad. There are 2 cams on the base of the rain collector that can be rotated to move the tipping spoon closer to or further away from the read switch. Make this adjustment and check if the LCD shows that the logger can detect manual tips of the spoon. If so, proceed to step 3. If not, the sensor may need to be sent in for service.
 3. If all the tips are being counted
 - a. Replace the rain bucket and trickle a known amount of water into the bucket. CAUTION: The rain bucket is self-emptying so be sure there are no electronics/important papers near the station while completing this task. 84 ml of water should register 0.1 inches of water (2.5 mm). This is equivalent to 10 tips of the tipping spoon. The best results are attained when the water is added slowly. It is

recommended that the water be put in a ziplock bag which is then punctured with a pin to allow the water to slowly enter the rain bucket. If the reading on the LCD is slightly high or slightly low, the sensor can be calibrated. When the spoon tips, it lands on screws on either side. If sensor is reading high, lower the screws. If it is reading low, raise the screws. It is recommended to adjust the screws a quarter turn and again run a known amount of water through the bucket to determine if additional adjustment is necessary.

- iv. Thermometer/Relative Humidity:
 - 1. If the temperature or humidity on the display seems unusually high/low
 - a. Ensure the sensor is fully plugged in
 - b. Check for broken or exposed wires along the cable
- v. Soil thermometer:
 - 1. If the soil thermometer display does not register or varies significantly from the air temperature
 - a. Ensure the units on the display match the intended units. If the units do not match use the "Set" button to set the sensor type. Use the arrow keys to select to appropriate port and hit "Set". Use the arrow keys again to select the correct sensor and hit "Set" again.
 - b. Ensure the cable is fully plugged in.
 - c. Check for broken or exposed wires along the cable.
- vi. Soil moisture sensor:
 - 1. If the sensor display reads anything other than 0% VWC in air
 - a. Ensure the sensor is fully plugged in
 - b. Check for broken or exposed wires along the cable
 - 2. If the sensor seems fine in air, but season data has issues
 - a. Place the sensor in distilled water. If the sensor does not read ~55% VWC it may need to be calibrated/replaced.
- vii. Solar radiation sensor:
 - 1. If the solar radiation sensor display reads zero
 - a. Ensure the sensor is fully plugged in
 - b. Check for broken or exposed wires along the cable
 - c. Ensure the units on the display match the intended units. If the units do not match use the "Set" button to set the sensor type. Use the arrow keys to select to appropriate port and hit "Set". Use the arrow keys again to select the correct sensor and hit "Set" again.
 - 2. If the solar radiation display reads a very low number (<500 W/m²)
 - a. Repeat steps a-c in item 1 above
 - b. If it is sunny take the weather station outside to see if the numbers improve. The solar constant is 1400 W/m² so you shouldn't have any values greater than that.