End of Cycle Report | December 29, 2023 | Public Release

# In the Arena | Water Resiliency Phase I 2021-2023

## Key Infrastructure Milestones, AMPLIFY Total Ag Water Management

- 1,680 LF 10 cm (4") diameter irrigation trunk line and 8 hydrant service points for overhead traveling gun irrigation capability. (Tidewater site)
- Remote control subsurface drip irrigation (SDI) capability in Optimal and Wet treatment blocks. (Tidewater and Bath sites)
- Pumping station with VFD capability for canal water withdrawal and distribution. (Tidewater site)
- Subirrigation and SDI flow control, filtration, and metering elements. (Tidewater and Bath sites)
- Drainage vault outflow control valve, and control and guard tanks water table depth level monitoring retrofit in 8 instrument houses. (Tidewater site)
- CR1000x datalogger installation, programming, and remote access capability for wired SDI-12 communication protocol drainage vault and field sensors. (Tidewater site)
- LP gas-fired 38 kW backup generator and transfer switch for uninterrupted power supply to groundwater pumps and instrument houses.

"Building infrastructure is hard work but when the outcomes are tangible and beneficial to farmers making more informed choices then the hardship melts away." Technical Specialist Robert Walters

## Key Project Milestones, AMPLIFY Total Ag Water Management

- **Detecting In-season Crop Water Stress to Improve Climate Resiliency and Nutrient Use 2/01/22 – 1/31/24 NC Corn Grower's Assn.**

  Designed to examine further relationships between water stress, yield, and nutrient utilization in the maize cropping system. Focusing on primary cost center inputs of seed, fertility, and water management infrastructure in the Blacklands region of North Carolina, this research and extension activity mobilizes UAV imaging, field sensors, and genetics from agribusiness partners to characterize maize response to in-season water stress better.

- **Evaluation of Corn Hybrids for Climate Resiliency and Nutrient Use. 2/01/21 – 1/31/24 NC Corn Grower's Assn.**

  Trials were conducted at two field sites, Tidewater and Bath, to evaluate maize yield, yield components, and fertilizer nitrogen and phosphorus utilization under varying field soil water exposures. The goal is to generate objective data for hybrid selection and nutrient needs given observed and expected soil-water conditions for individual Blackland farms. Three technical reports have been issued to growers, extension agents, and consultants.

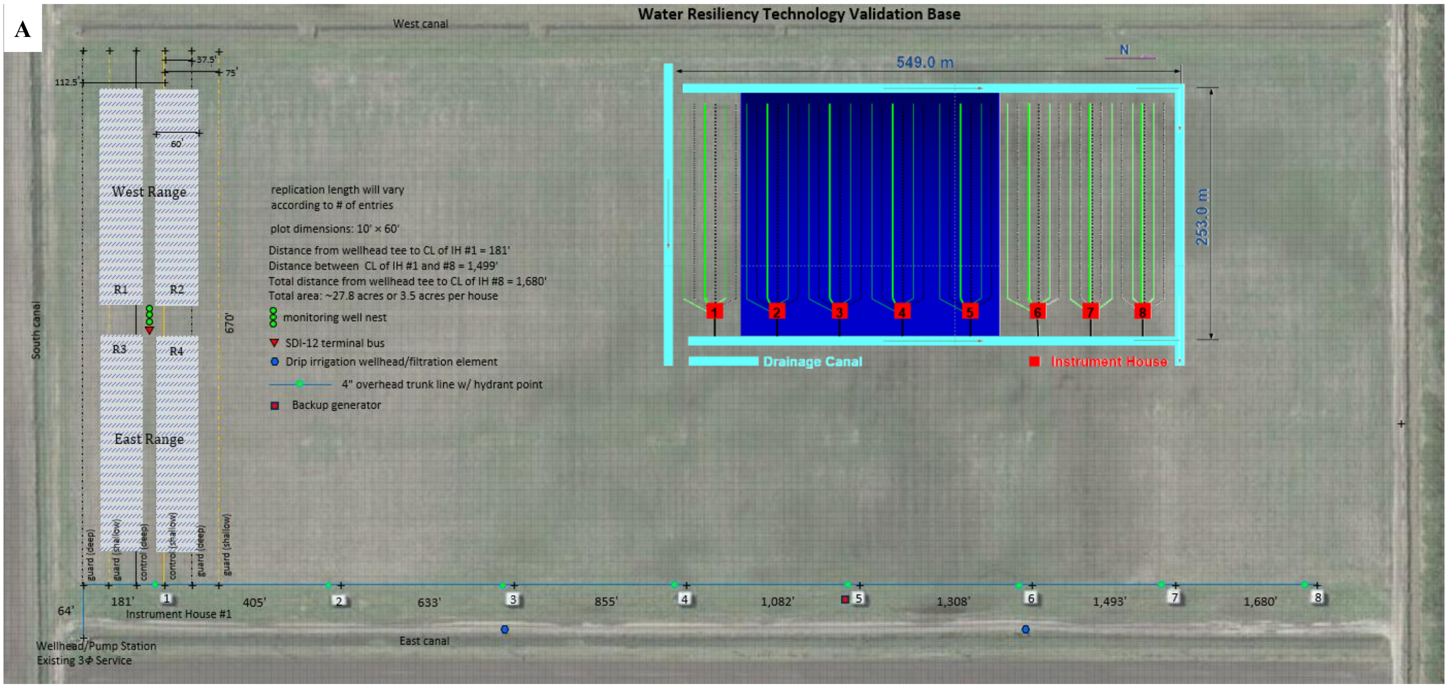
- **Evaluation of Soybean Varieties for Climate Resiliency and Nutrient Use. 2/01/22 – 1/31/24 NC Soybean Grower's Assn.**

  Trials were conducted at two field sites, Tidewater and Bath, to evaluate soybean yield, yield components, and nutrient utilization under varying field soil water exposures. The goal is to generate objective data for variety selection and nutrient needs given observed and expected soil-water conditions for individual Blackland farms. Two technical reports from this work have been issued to growers, extension agents, and consultants.

- **Detecting In-season Crop Water Stress to Improve Climate Resiliency and Nutrient Use 2/01/23 – 1/31/24 NC Soybean Grower's Assn.**

  Designed to examine further relationships between water stress, yield, and nutrient utilization in the soybean cropping system. Focusing on primary cost center inputs of seed, fertility, and water management infrastructure in the Blacklands region of North Carolina, this research and extension activity mobilizes UAV imaging, field sensors, and genetics from agribusiness partners to characterize soybean response to in-season water stress better.

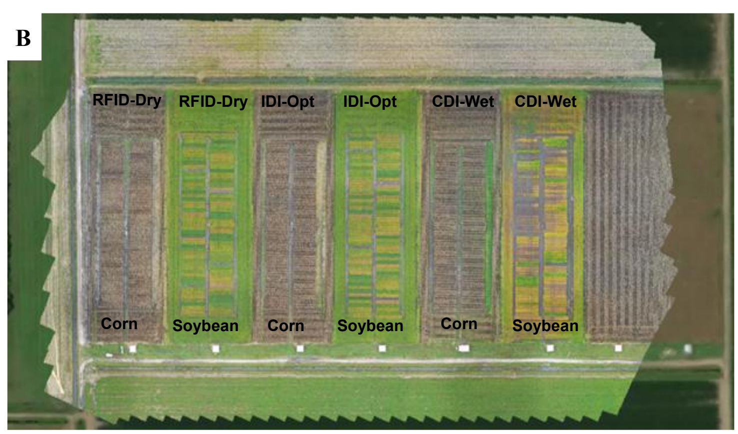
## Site Description – Tidewater




The Tidewater site is situated on 13.8 ha (34.3 ac) of nearly level cropland located near the town of Roper (35˚50'44.79" N, 76˚40'4.47" W) in Washington County, North Carolina. The land, first cleared in 1975, is enclosed on all sides by interconnected, open drainage canals approximately 2 m deep and is part of the NCDA & CS Tidewater Research Station. Two subsurface drainage systems were installed at the site at different times: first, in 1985, parallel, 10 cm (4") polyethylene tiles spaced 22.9 m (75') apart at an average depth of 0.9 m (3'), herein termed "shallow". A second system of similar materials was installed in 1991 midway between the old drain lines at a depth of 1.2 m (3.9'), herein termed "deep" (Figure A). The second, newer system was installed to overcome the limitation of low hydraulic conductivity in the zone surrounding the old drain lines and to improve drainage efficiency while providing a mechanism to vary drainage intensity by opening and closing control valves that discharge into a constructed underground drainage vault. The same design was implemented across the field, effectively dividing the site into eight hydraulically independent drainage zones, each served by an instrument house and an underground discharge vault. Instrument houses are equipped with pumps, water table and flow control elements, all wired to a CS1000x datalogger for continuous monitoring. Three 5-cm-diameter wells are located downfield of the instrument houses for groundwater monitoring and sampling. Field sensors are connected to an SDI-12 terminal bus, which is linked to the CS1000x datalogger via an underground conduit.

Currently, three drainage and irrigation level treatments have been implemented at the Tidewater and Bath sites:

- Rainfed + Intensive Drain (RFID-Dry): intended to create drier than normal conditions typical of freely draining sites in NC. Soil water matric potential is governed entirely by natural rainfall with 11.5 m (37.5') O.C. tile drains discharging at full capacity throughout the growing season. (Figure B)
- Intensive Drainage + Irrigation (IDI-Optimal): intended to create ideal conditions representative of economically efficient water management systems. Soil water matric potentials are continuously monitored at 20 cm and 50 cm (8" and 20") deep in the root zone with subsurface drip irrigation used to apply water during drier-than-normal periods. (Figure B)
- Controlled Drainage + Irrigation (CDI-Wet): Intended to create wet stress conditions. Tile drainage spacing is 11.5 m (37.5') and controlled to both reduce and/or stop drainage to impose wet stress artificially. This is coupled with subsurface drip irrigation to further impose wet stress. The drainage outlet is not permitted to free-flow unless the groundwater level is between 0 cm and 30 cm below the surface. Irrigation water is continuously pumped into the drainage system when the water table falls below 30 cm, and daily subsurface drip irrigation is applied to intensify wet stress. This treatment would represent river bottoms, tidally controlled drainage areas, and small depressional areas. (Figure B)



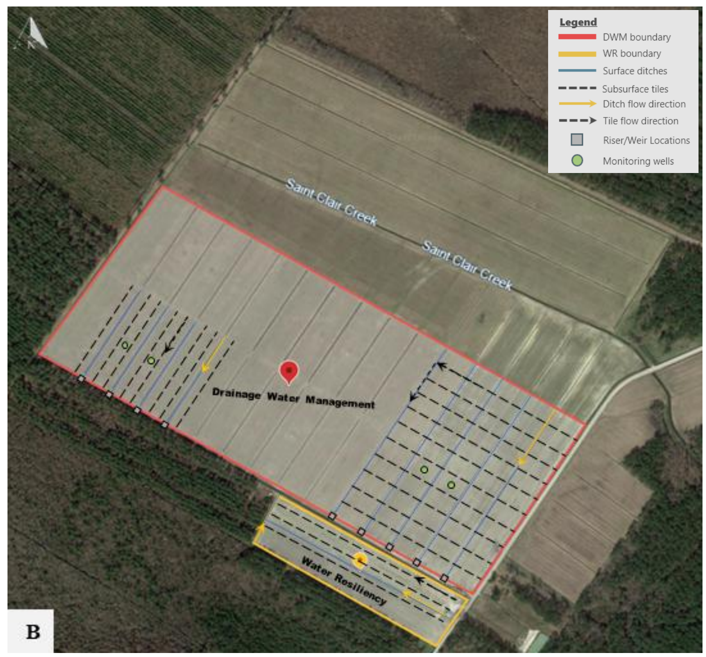

Aerial view of corn and soybean plots in mid-September 2023 at the AMPLIFY Total Agricultural Water Management site, Plymouth, NC. Treatment blocks are maintained in a corn-soybean rotation following producers in the region.
*Image: J. Ward*

## Site Description – Bath

The Bath site is situated on 40 ha (99 ac) of nearly level cropland located near the town of Bath (35°28'38" N, 76°48'41" W) in Beaufort County, North Carolina. The land is privately owned. The primary soil type is Portsmouth loam, classified as very poorly drained on a 0-2% slope range. Inclusions of poorly drained Tomotley fine sandy loam also occur to a minor extent. The site has two experimental units: (1) AMPLIFY Water Resiliency; and (2) Drainage Water Management. An open drainage canal ~2 m deep running NW-SE divides the two units (Figures A, B).

The **Drainage Water Management (DWM)** site was designed to examine the agronomic and environmental ramifications of shallow (0.30 m deep × 1.2 m wide × 382 m long) and conventional (1.07 m deep × 1.5 m wide × 183 m long) surface ditches. Both ditches are spaced 60 m apart and were installed in 2008 with laser-guided equipment intended to convey excess water away from the field during wet periods or impound water during dry periods. Surface land leveling was performed in 2008 to crown the area between the ditches to encourage surface water to move away from the mid-point toward the ditches. Subsurface tile drains 10 cm diameter × 1.1 m deep × 20 m apart were installed in 2014 on 0.1% grade with the same laser-guided equipment. The shallow ditch system has a single main line ditch to accommodate outflow from the 10 cm tiles which run perpendicular to the surface ditches. An outlet riser installed at the exit point of the main line ditch receives all subsurface tile line discharge for the subunit (Figure C). In the conventional subunit the subsurface tiles run parallel to the surface ditches and outlet to flashboard risers installed at exit points (Figure D). Risers are equipped with adjustable-height gates that allow the subsurface drainage to manually change between freely draining (FD) and controlled drainage (CD).

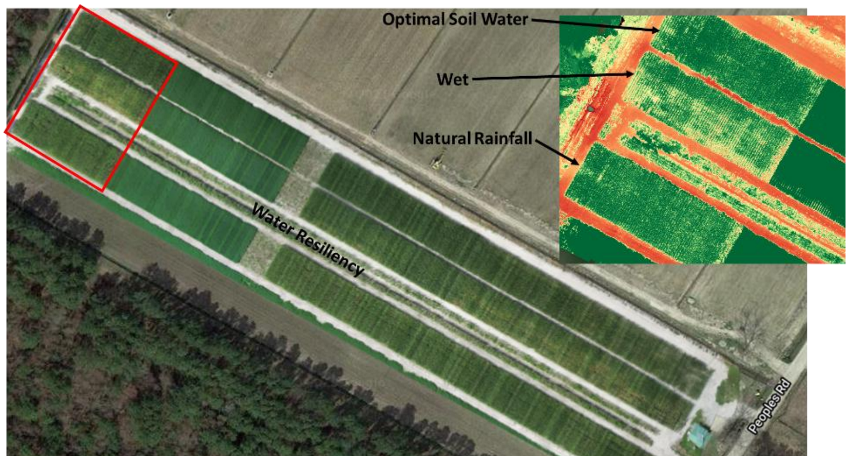
The **Water Resiliency (WR)** site, established 2021, consists of three blocks approximately 15 m wide × 366 m long, each underlain by a single 10 cm subsurface tile drain buried on the same DWM grade and approximate depth discharging to an open ditch ~1.2 m deep. The site was designed to mimic the three soil-water management treatments at Tidewater so generating independent site-year observations for corn and soybean. Drip irrigation lines buried 30 cm deep × 0.3 m apart run parallel to the subsurface drain tiles and cover the full breadth and length of the Optimal and Wet treatment blocks (Figure E). Drip lines are fed by a VFD well pump housed adjacent to the field site with flow control/metering and filtration elements installed in front of the flashboard riser at the ditch exit point (Figure F).





## Site Description-Bath continued.




**G** Aerial view of the Bath Water Resiliency Peoples Road site. Inset: false color thermal infrared image of corn and soybean plots midsummer 2022.

**H** Canal separating the DWM and WR units at the Bath site. An otter can be seen frolicking in the water (green circle).

**I** Preparing the WR unit for planting April 2022.

**J** John Deere 6110M tractor and precision planter used to plant corn and soybean plots. Randomized plot schedules are loaded into the tractor's computer providing positional guidance to the operator where to place the seed.

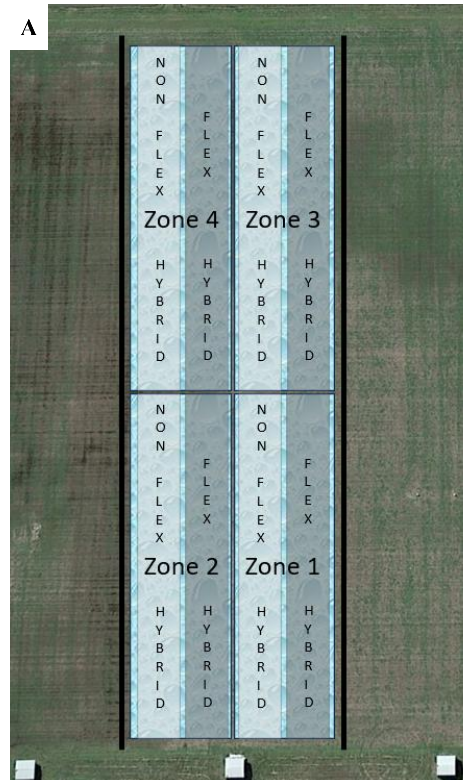
**K** Production-scale machinery is used to plant and harvest the area between surface drains in the DWM unit. Yield maps are used to evaluate the spatial distribution of corn and soybean productivity relative to the drain lines.

**L** Small plots combine harvesting soybeans at the WR unit, October 2023.

**M** Flashboard riser controls at the main line ditch exit point, shallow ditch system.

## Phase II 2024-2026 Priorities

- Expand SDI capabilities to include all treatment blocks at the Tidewater and Bath sites. This will allow for rotating field soil water treatments annually to minimize the location × treatment bias associated with fixed SDI infrastructure.
- Subdivide field blocks serviced by instrument houses 7 and 8 at Tidewater into separate irrigation × planting density zones to further evaluate the response to planting density and nitrogen fertilization rate on flex and non-flex corn genetics (Figure A). There is a large body of knowledge of plant density consequences on nitrogen utilization dynamics in corn but few if any of these studies have prescriptive irrigation based on crop water demand or in-season groundwater monitoring for environmental quality (fertilizer N and P).
- A proposal to partly underwrite the cost of infrastructure improvements for the field blocks serviced by instrument houses 7 and 8 at Tidewater was submitted to the Corn Grower's Association of North Carolina in Fall 2023 for review.
- Expand infrastructure improvement cost sharing to include federal sources tied to measured environmental benefits of controlled drainage and precision soil water management.
- Expand training opportunities on advanced technologies for in-season root zone soil water monitoring (frequency, time, and amplitude domain reflectance; time and phase domain transmission). A field area at the Tidewater site has been dedicated for this purpose but one at the Bath site should also be established.
- Develop user friendly methods for estimating site-specific field capacity, permanent wilting point, and available water capacity using matric potential-volumetric soil water relationships and demonstrate how to use these for irrigation scheduling.

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