Developing Climate Resilient Crops

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We strive to make food, food production, and food supply to be safe, secure, nutritious, cost-effective and plentiful in the U.S. and the world.
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ARS is a Mission-Driven Organization

Our mission is to conduct research (farm-to-table) to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to:

- Food Security
- Bioenergy
- Climate Change
- Childhood Obesity
- Food Safety

‘Appalachian White’ winter wheat – 1st wheat developed with Ug99 rust resistance for U.S. production by USDA-ARS
Current USDA-ARS Climate Change Projects in the Carolinas

- Strategies to Predict and Manipulate Responses of Crops and Crop Disease to Anticipated Changes of Carbon Dioxide, Ozone, and Temperature (Raleigh, NC).
- Biologically Based Fertilizer Recommendations to Meet Yield Expectations and Preserve Water Quality (Raleigh, NC).
- Pyrolysis - An Environmentally Sustainable Process to Create Designer Biochars to Improve Soil Fertility in Southeast USA Coastal Plain Soils (Florence, SC).
- Improving Chemical, Physical, and Biological Properties of Degraded Sandy Soils for Environmentally Sustainable Production (Florence, SC).
Traits to improve for climate-resilient crops

- Cold/Heat Tolerance
- Flowering Time
- Drought Tolerance
- CO₂ Assimilation
- O₃ Tolerance
- Nitrogen uptake
- Pathogen/Pest Resistance
Effect of Ozone, CO$_2$, Vapor Pressure Deficit and Temperature Fluctuation on Wheat, Yellow Rust, and Stem Rust Development

OPEC – Outdoor Plant Environment Chamber
Identified 2 wheat lines that varied in their ozone response.

Developed a Recombinant Inbred Line (RIL) Mapping Population having 279 lines.

Preliminary Data:
• Two or three genes responsible for O$_3$ tolerance.
• CO$_2$ and O$_3$ have different effects on grain quality.
Wheat Stripe Rust susceptibility - resistance
Kenya Agricultural Research Institute, Njoro, Kenya

Breeding for Stem Rust Resistance
Wheat Productivity Enhancement Project (WPEP) in Pakistan:
- Heat and Drought screening
- Rust Resistance
- Yield Potential
New Sources of Ozone Tolerance in Progenitor Species

Triticum aestivum

Triticum umbellulatum

Triticum monococcum

Triticum cylindricum

Triticum triunciale
Conclusions – Better Understanding of Interacting Effects and Development of Climate-Resilient Wheat

Genetic Gain = Selection Differential x Heritability x $\sqrt{\text{Phenotypic Variance}}$ / Time

▲ Selection Differential by Better Plant Response via OPECs.
▲ Heritability by Understanding Gene Action.
▲ Phenotypic Variation by Identifying New Sources of Resistance
▼ Time by Developing Molecular Markers via the Mapping Population.
Every large-scale disease and insect problem over the last 80 years has been solved through sustained international cooperation, collaboration and exchange of germplasm and its subsequent use. It’s the sharing ideas and technology, and collaborative research that will solve agricultural problems today and into the future.

“There are no miracles in agricultural production.” … “Food is the moral right of all who are born into this world.”

Norman E. Borlaug