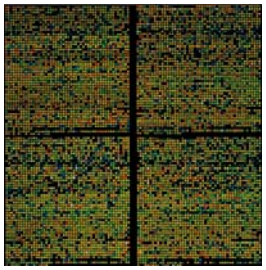
Global Change, Cont'd

Experiments with ozone concentrations use open top chambers where ozone can be removed with charcoal filters or added to create higher levels. Cultivars of soybean differing in tolerance of ozone are tested to determine the role of vitamin C metabolism in protecting from ozone damage.

Use of artificially illuminated growth cabinets allows experiments to be conducted throughout the year. These chambers also allow researchers to isolate the effects of single environmental factors on plant responses, in order to better understand the responses observed in more complicated environments such as SPAR chambers, open top chambers, and the field.

Changes in the expression of genes with exposure to elevated carbon dioxide concentrations are being examined using differential display and micro array techniques. This will allow us to understand why physiological responses to carbon dioxide change after long-term exposure in some crop varieties but not in others. Determining which changes in gene expression are favorable and unfavorable will aid in the development of new crop varieties better adapted to elevated carbon dioxide conditions.



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Beltsville Agricultural Research Center (BARC)

U.S. Dept. of Agriculture

ARS

Crop Systems & Global Change Lab
Agricultural Research Service
Plant Sciences Institute
10300 Baltimore Ave.
Bldg. 001, Rm. 342, BARC-West
Beltsville, MD 20705-2350

Phone: 301-504-5872
Fax: 301-504-5823
Email: vreddy@asrr.arsusda.gov
http://www.ars.usda.gov/ba/psi/csgcl

Beltsville Agricultural Research Center

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Crop Systems and Global Change Lab

Applying Systems Theory To Complex Agricultural Problems

- **Improving Crop Management Decision Making**
- **Predicting Consequences of Global Environmental Change**
- **Adapting Crops and Management Strategies to Global Environmental Change**

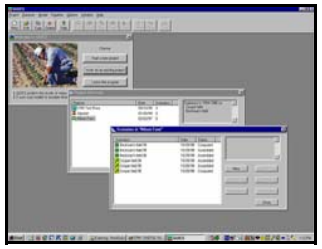
Crop Simulation Models for On-farm Resource Management

Crop simulation models are computer programs that mimic the growth and development of crops. Data on weather, soil properties, and crop management are processed to predict crop yield, maturity date, efficiency of fertilizer application, and other elements of crop production. The calculations are based on existing knowledge of the physics, physiology and ecology of crop responses to the environment.

The CSGCL has developed and is developing crop simulation models to aid farmers in making crop management decisions which will improve resource use efficiency and increase profitability, and also to answer research questions involving Global Environmental Change, Precision Agriculture, Soil Hydrology and Plant Physiology.

The following models are available through the CSGCL:

GUICS: Graphical User-Interface for Crop Simulators
The Crop Systems and Global Change Lab has developed a generic Graphical User Interface for Crop Simulators (GUICS) to make crop simulators easier for farmers to use. GUICS helps users select soil, weather, cultivar, and management files for various scenarios, automatically downloads data from a weather station and displays results in text or graphics.



CPM: The Cotton Production Model
CPM features a modular, generic, object-oriented design and is programmed in C++. CPM was interfaced with GUICS and is currently being validated by an independent team of ARS and university researchers and extension agents from across the cotton belt.

GLYCIM: A Dynamic, Mechanistic Soybean Crop Model
The soybean crop simulation model GLYCIM has been in use as a farm decision-aid since 1991, and is now on farms in nine states. Farmers interact with GLYCIM through a Graphical User Interface for Crop Simulators (GUICS). The farmers use GLYCIM for the selection of cultivar/soil type combination, planting date, row spacing, irrigation scheduling, harvest timing and yield prediction.

2DSOIL: A Two-dimensional Soil Process Model
2DSOIL, a finite element model, is the first comprehensive, modular, two-dimensional soil model that can simulate the major physical, chemical and biological processes in soil. Its modularity makes it easy to modify, and incorporate into plant models. A graphical user interface to develop a finite element mesh, 2DSOILMesh, has also been developed.

SPUDSIM: A Potato Simulation Model
SPUDSIM is based on the ARS potato model SIMPOTATO and uses 2DSOIL for simulating soil processes. The model provides a detailed representation of nitrogen soil dynamics and leaching. SPUDSIM has been used to evaluate nitrogen management practices for potato in Minnesota.

MelonMan: A Simple Cantaloupe Phenology Model
A simple, cultivar specific, cantaloupe phenology model that uses standard weather data and predicts leaf appearance, crop developmental stages and final harvest date. The use of this model will allow cantaloupe producers to accurately predict harvest date as well as provide a tool for managing crop growth stage dependent applications of fertilizer, pesticides and irrigation.

MaizeSim: A process-based crop simulation model for corn
MaizeSim is a modular process-based crop simulation model for corn. This model has been built upon the current knowledge in physiology and ecology of corn plants. Current version simulates potential growth and development as a function of key environmental variables encompassing light, temperature, CO_2, humidity, etc. The final version will be interfaced with GUICS and 2DSOIL with which balances of water and nutrients between plants and the soil will be implemented.

Other models that are available:
2DLEAF: A New Model of Leaf Gas Exchange
GOSSYM: A Cotton Simulation Model

Global Environmental Change

Global changes in several environmental factors, such as atmospheric carbon dioxide concentration and tropospheric ozone concentrations are occurring, in addition to the predicted global warming. The projected changes could have many serious consequences for agriculture, and ensuring an abundant and high quality supply of food and fiber will require adapting crops and crop management strategies to the altered environmental conditions.

Experimental systems for exposing crops and weeds to altered environmental conditions include outdoor, naturally sunlit chambers refered to as SPAR (Soil Plant Atmospheric Research) units, which provide precise control of the major environmental factors influencing plant growth, including temperature, humidity and carbon dioxide concentration. The SPAR units are fully automated to measure canopy gas exchange including photosynthesis, respiration and water use. Root compartments have windows which allow root growth to be monitored.


SPAR Unit

Another experimental system is the use of a "natural laboratory" consisting of three sites radiating out from the center of Baltimore to a rural site near Buckeystown, Maryland to study responses to the combination of elevated temperature and carbon dioxide concentration associated both with urbanization and with global change. The changes in carbon dioxide concentration and temperature from the rural site to the city center mimic those projected over the next 50 years for the atmosphere as a whole.


Experimental plot near Baltimore Science Center