On-farm Trials Demonstrate Maize Yield Increases under Drought

Global maize production must meet the dual demands of global consumption and sustainable production, and maize breeders and agronomists have collaborated to improve yields under both environmentally challenging and optimal growing conditions. Yet, maize remains vulnerable to drought conditions, especially during flowering time, leading potentially to severe yield reductions.

In the July–August 2015 issue of *Crop Science*, researchers report on a six-year study that demonstrates how combined breeding and agronomy efforts can maintain or even improve yield potential under good growing conditions, reduce risk to growers when moisture is limiting, and help meet food and feed demands in a sustainable manner. The study included three years of small-plot research experiments, on-farm evaluations at multiple locations, and agronomic testing conducted under various plant population numbers, in support of the release of Optimum AQUAmax brand hybrids.

The yield of AQUAmax hybrids was 2 to 3% higher than that of the leading checks when grown in favorable environments, and 5 to 9% percent higher when grown in water-limited environments. Under water-limited conditions the AQUAmax hybrids also demonstrated improved yield as plant population increased. This industry-scale evaluation demonstrates the value of multidisciplinary research focused on the needs of growers.


Cover Crops: A Potential Solution for Weed and Nitrogen Management

Smallholder crop productivity is very low in southern Africa, and particularly in Zimbabwe. One of the main causes of this low productivity is poor nitrogen and weed management caused, in part, by unaffordability and inaccessibility of mineral fertilizers and herbicides by the cash-constrained farmers. There is need for identification of alternatives to these external inputs, and the integration of green manure cover crops (GMCCs) is a potential solution which has not been investigated in depth in Zimbabwe.

In a study in the July–August 2015 issue of *Crop Science*, the use of GMCCs as weed and nitrogen management tools in rotation with maize was investigated in contrasting soil types over five years. The results of the study showed yield increases of up to 6% in maize rotated with jack bean (*Canavalia ensiformis*) compared with maize monocropped in a sandy soil. In maize rotated with black sunnhemp (*Crotalaria juncea*), weed densities decreased by up to 94%.

Cover crops may be integrated into smallholder farming to aid in weed and nitrogen management; however, there is a need to identify niches for each cover crop since no single cover crop can provide all of the benefits. Adoption of rotations will depend on each farmer’s particular situation.

Adapted from Mhlanga, B., S. Cheesman, B. Maasdorp, W. Mupangwa, and C. Thierfelder. 2015. Contribution of cover crops to the productivity of maize-based conservation agriculture systems in Zimbabwe. Crop Sci. 55(4). View the full article online at http://dx.doi.org/doi:10.2135/cropsci2014.11.0796

In a water-limited field environment in Nebraska, this photo shows AQUAmax P1151HR not demonstrating significant leaf rolling while the competitive check hybrid is rolling consistently. Corn under stress will roll leaves to limit exposure to the sun, which causes moisture to evaporate from the leaves. The rolled leaves can’t continue photosynthesis, so plant growth shuts down.

**Pioneer® brand Optimum® AQUAmax® product P1151HR**

In a water-limited field environment in Nebraska, this photo shows AQUAmax P1151HR not demonstrating significant leaf rolling while the competitive check hybrid is rolling consistently. Corn under stress will roll leaves to limit exposure to the sun, which causes moisture to evaporate from the leaves. The rolled leaves can’t continue photosynthesis, so plant growth shuts down.

Black sunnhemp (*Crotalaria juncea*). Photo courtesy of Wikimedia Commons/A16898.
Salinity Tolerance is Heritable in Perennial Ryegrass

Water conservation is a necessary and responsible practice, especially in urban landscapes and golf courses that use a lot of water. Turfgrass areas are the perfect environments for irrigating with reclaimed or alternative water sources, such as effluent water, seawater, and gray water, because turf is not grown for food. Watering turfgrass with effluent water also reduces the use of high-quality, potable water for irrigation. However, these alternative water sources often contain high levels of total soluble salts, resulting potentially in increased soil salinity and salt stress injury, and leading to poor turf quality. Turfgrass cultivars with improved salinity tolerance therefore need to be developed to encourage the use of effluent water to irrigate turf.

In July–August 2015 issue of Crop Science, researchers report on several classical genetic studies to determine the inheritance of salinity tolerance in perennial ryegrass. The authors found that broad-sense (0.78) and narrow-sense (0.72-0.66) heritability estimates were relatively high, and that general combining ability accounted for more of the variation than specific combining ability.

These results indicate that additive gene effects are important for salinity tolerance in perennial ryegrass, implying that a recurrent selection program which concentrates additive alleles will be an effective breeding strategy for improving the plant's salinity tolerance. This research should help improve the efficiency breeding efforts to develop turfgrass cultivars with greater salt tolerance.


Oxygen Diffusion and Water Retention in Soil Aboard the International Space Station

People often speculate about the capacity of Mars and other planets to sustain human settlements. However, a central question from vadose zone hydrology must first be answered: Given how important water movement in the pore spaces of soil is to plant growth, how does water move in porous media under conditions of reduced gravity—or one millionth the gravity of Earth?

A research team addresses this in the June 2015 issue of the Vadose Zone Journal (VZJ). The paper is part of a VZJ special collection entitled: “Organic Material Used In Agriculture, Horticulture, Reconstructed Soils, and Filtering Applications” (see more on next page).

The study analyzed data collected aboard the International Space Station from 6 July to 9 Oct. 2007. The purpose was to measure the movement, distribution, and interactions of water and oxygen under microgravity conditions.

The team saw no significant difference in water and oxygen dynamics (diffusivity and porosity parameters) for the wetting phase of soil. However, differences were seen in the drying phase, including a higher percolation threshold (i.e., lower connectedness of air-filled pores), increased tortuosity, and decreased diffusivity.

They attributed these differences to changes in capillarity under reduced gravity. The authors also observed the creation of “water clusters,” which they define as a non-uniformity of water filled pores, suggesting the need to better understand and measure temporal and spatial distributions of water under microgravity to improve root functions.

Comparing Soybean-based Biodiesel Life Cycle Assessments

Soybeans are a foundational element of both the food system and systems for non-food bio-products, such as biodiesel. As such, soybean-based biodiesel has become a “fuel standard” by which other biodiesels are compared. However, direct comparisons of the impacts of fuels can be difficult because life cycle assessment (LCA) methodologies are generally not standardized.

In a study in the July-August issue of the Journal of Environmental Quality, researchers conducted a meta-analysis to equate soybean-based biodiesel LCA studies, assessing results based on state-level location, agricultural management practices, and analysis methodology.

After standardizing assessments from the literature, the team found that considerable variability still existed in reported impacts due to sampling, methodology, and agricultural management. However, mean results for soybean biodiesel were similar to the California Low Carbon Fuel Standard. Information was available in the literature for this fuel’s global warming potential, but data on acidification and eutrophication potentials were limited. These latter potentials can contribute substantially to the LCA impacts of biodiesel production, and are generally influenced by fertilizer use.

When comparing studies, researchers must take care to understand the effects of data selection, feedstock production variations, and methodology on the results. However, when using well-documented LCA methods, worthwhile comparisons can be made that overcome study variations.


Can Woody Debris Store Carbon in Grazinglands?

Policy to offset carbon dioxide pollution in the agricultural sector focuses on manipulating the terrestrial carbon cycle through reforestation and increased retention of carbon within soils. There has also been significant research devoted to understanding how to increase short- and long-term carbon sequestration; strategies developed within the Kyoto Protocol include agroforestry practices, ecosystem rehabilitation, and creation of forest reserves in various agro-ecosystems.

However, there is also the potential to sequester more carbon in these ecosystems through a simple modification of existing land management practice: the retention of coarse woody debris (CWD), or fallen timber. In a study in the July-August issue of the Journal of Environmental Quality, a team reports that retaining CWD in Australian woodlands could store 8 to 15 more tons of carbon per hectare.

The retention of CWD in woodland ecosystems represents a great opportunity, with low capital inputs, to store carbon within woodland ecosystems worldwide, conclude the authors. This form of restoration involves minimal effort and doesn’t require land use change and associated social, cultural, and ecological consequences, thus allowing continued sheep and cattle production in rangelands.

Ranchers and other land managers must still give careful consideration to maintaining production and profitability, however, as well as to the fuel load increase, fire risk, and health and safety issues that would accompany the retention of CWD in temperate woodland landscapes used for grazing.

Ability of APEX to Simulate Dissolved Phosphorus Loads in Tile Drainage

Tile drainage is a necessary practice in poorly drained areas of the U.S. Midwest. However, it has also been documented as a significant pathway for transporting dissolved reactive phosphorus (DRP) to surface water bodies, leading to harmful and nuisance algal blooms. To adequately manage nutrient delivery at the field scale in tile-drained landscapes, numerical modeling tools must effectively simulate dynamics across soil, topographic, climate, and management gradients.

In the July-August issue of the Journal of Environmental Quality, researchers from USDA-ARS and Texas A&M University examined the ability of a widely used hydrology and water quality model, APEX, to simulate DRP loads across edge-of-field sites in Central to Northwestern Ohio.

The authors found that APEX simulates monthly to annual DRP loads in both surface and subsurface pathways well except during high-loading periods to tile when preferential flow appears to be prominent. The study also provides insight into the control that organic and inorganic soil P concentrations exert on baseline DRP concentrations in tile drainage.

While APEX is a fairly robust tool for simulating the impacts of agricultural management on DRP loadings from tile drainage, some limitations exist regarding high concentrations that are routed through preferential pathways. New routines are thus needed to account for these loadings. For conditions under which the model works well, results suggest that tile DRP concentrations will exceed thresholds for algal proliferation regardless of management and that alternative management strategies need to consider potential feedbacks to surface runoff and other pollutants.


Sludge Biochar Immobilizes Arsenic in the Environment

Approximately 25 million Mg of sewage sludge is produced annually by municipal wastewater treatment plants in China. In view of the presence of environmental contaminants, the direct use of sludge as a fertilizer in agriculture is increasingly controversial and will be restricted by legislation in the future.

In the July-August issue of the Journal of Environmental Quality, researchers report on the efficacy of iron-rich biochar produced by sludge pyrolysis for immobilizing arsenic in the environment. This study elucidated the effects of solution chemistry on the sorption behavior of trivalent arsenic, which is more mobile and toxic, in order to safeguard environmental applications of sludge-derived biochar.

The team found that the sorption capacity of sludge-derived biochar was comparable to other sorbents, and spectroscopic analysis suggested that ligand exchange was occurring on the biochar surface. Arsenic sorption was independent of solution pH in the acidic and neutral range but was more favorable under alkaline conditions and a higher ionic strength. Although concentrated carbonate and phosphate inhibited arsenic sorption, sludge-derived biochar should be applicable for arsenic immobilization under most field conditions.

Overall, these results suggest that sewage sludge pyrolysis produces a biochar that is an effective soil amendment for environmental remediation and nutrient recovery.


Photo courtesy of Kevin King.
Ten-Year Study Shows Manure Application Enhances Soil Organic Matter

Land application of animal waste benefits both soil and crops. It is estimated that up to 75% of nitrogen, 60% of phosphorus, and 80% of potassium fed to dairy cattle, and 50% of N, P, and sulfur from dietary intake of swine are excreted as manure and other wastes. Most states in the Great Plains rank in the top 12 in U.S. cattle and swine populations. However, research on the long-term effect of applying waste products from these animals on soil physical and chemical properties in comparison with inorganic fertilizer is scarce.

In the May-June 2015 issue of the *Soil Science Society of America Journal*, a 10-year field study in Kansas compared three levels of cattle manure, swine effluent, and inorganic fertilizer, along with a control, on soil physicochemical properties.

In general, application of cattle manure enhanced soil organic matter (OM) content and improved soil physical properties compared with other treatments, but caused excessive levels of soil test P. Significant relationships ($P<0.001$) were observed between OM and soil water content at -1.5 MPa; both Proctor max and field bulk densities; optimum water content for compaction; and steady-state infiltration rate.

Overall, the researchers conclude that cattle manure improves soil resistance to compaction, largely due to the additional OM that accumulates from long-term application of manure.


Mobilization of Phosphorus from Creek Sediments

Creeks and rivers are often considered only as delivery routes for phosphorus (P) from land to larger water bodies, with little regard given to biogeochemical processes at the sediment-water interface that influence P forms and fate. Past studies of these processes relied largely on sorption equilibria to characterize retention and remobilization of P from sediment. However, a full analysis of different physiochemical and biological parameters, and their site specific variations, is required to better understand the fate of legacy P accumulated in river sediments.

In the May-June 2015 issue of the *Soil Science Society of America Journal*, scientists reported on the effects of pH, salinity, temperature, and biologically mediated redox processes on sediment P mobilization from East Creek, a coastal estuary on Maryland’s lower eastern shore. They found that pH and biologically mediated redox changes affected P remobilization the most. In addition, upstream sites near intensively farmed areas with high sediment P content could release three to four times more P than wetland sediments in the lower reaches of the creek.

Interestingly, P was found to be continuously mobilized from sediments under current steady state conditions. In-phase periodicity of water oxygen isotope ratios with incoming and outgoing tides and corresponding changes in water column P concentrations constrained the role of tides in diluting and removing P from the upstream region of the creek. This study highlights the importance of biogeochemical parameters on the remobilization of legacy P from riverbed sediments and export from watersheds.


Sensitivity of different parameters on P mobilization in the East Creek. Negative values refer to retention, and positive values to remobilization/release from sediments. Normal condition represents the existing steady state condition.
Extended Perennial-based Rotations Preserve Soil Carbon and Sugarbeet Sucrose Yield

Sugarbeet is an economically important crop in the Big Horn Basin of Wyoming, USA where it’s regularly grown in two-year rotations with annuals such as barley or dry bean under furrow irrigation. These shorter rotations are frequently disturbed by tillage, which can deplete soil organic matter (SOM) over time. However, insufficient data exists on the combined effects of tillage and crop rotation on SOM fractions and crop productivity in low-rainfall areas under irrigation.

In the May–June 2015 issue of the *Soil Science Society of America Journal*, researchers reported on a long-term study, in which they evaluated sucrose yield and soil organic carbon and nitrogen fractions across four furrow-irrigated sugarbeet systems. These systems ranged from a frequently-tilled sugarbeet following barley or dry bean rotation to an extended rotation that included a perennial alfalfa crop.

The researchers found that surface soils (0–15 cm) under sugarbeet–barley or sugarbeet–dry bean contained 54% less soil organic C on average and lower sucrose yield than the three-year sugarbeet–barley–dry bean rotation and four-year sugarbeet–sugarbeet–alfalfa–alfalfa rotations. Labile C and N fractions, such as microbial biomass C, were also lower under the two-year rotations than the three- and four-year rotations. However, when normalized by total soil N and organic C, these active fractions were >1.5-times higher in the two-year rotations, suggesting greater soil organic matter mineralization.

The study demonstrated that growing sugarbeet in extended rotations with perennial crops, such as alfalfa, can preserve organic C and N fractions and build up SOM, without causing declines in sugarbeet sucrose yield.


Precision Guidance for Mustard Cover Crops

Farmers are increasingly looking to cover crops to meet their management goals, but cover crops must be used precisely for those goals to be met. Researchers from Cornell University, Michigan State, and University of Illinois recognized that guidance on mustard cover crops was inadequate because precise planting dates for cover crop success weren’t known for the Great Lakes region. In the July–August issue of *Agronomy Journal* they report that the planting window for this region is narrow and different from other regions of the country.

The team specifically found that mustards establish well if sown late in the summer during an approximately two-week window. The ideal sowing time varied with location, which the researchers could model by establishing sites across the region. When mustard established well, it smothered weeds germinating at the same time. However, there were no residual effects on weed suppression. As a result, cool-season weeds produced fewer seeds, but growers could not reduce their other weed management practices.

Overall, the authors urge growers not to act on expectations developed in other regions that will not be met in this one. The research was funded by the USDA Organic Research and Extension Initiative because of its particular importance for organic vegetable growers.


A successful stand of Tilney mustard, sown in August in Freeville, NY, and photographed in November, when it stopped growing before being killed by frost.
Improved Solar Radiation Use Contributes to Higher Maize Yields

Solar radiation has declined significantly in Northeast China during the last six decades. Planting improved hybrids has helped offset the negative effects of this decline on maize grain yields. However, the contribution that radiation use efficiency (RUE) and radiation interception make to higher grain yields of newer maize hybrids is not clear.

In one study published in *Agronomy Journal* in 1992, approximately 80% of the difference in crop growth rate (CGR) between older and newer hybrids could be attributed to higher RUE in the newer hybrids. Now, in a new study in the July–August 2015 issue, four commonly cultivated maize hybrids in Northeast China were selected for a two-year field study. Two hybrids were released in the 1970s and the other two in the 1990s.

The researchers found that the 1990s maize hybrids showed significant increases in dry matter at maturity and grain yields compared with the older hybrids. The scientists concluded that greater dry matter accumulation was primarily responsible for the yield increase in the newer hybrids, which occurred mainly during the tasseling-to-maturity stage.

The newer hybrids also showed significant improvements in CGR and RUE, particularly during the tasseling-to-maturity stage. In particular, the fraction of photosynthetically active radiation (PAR) intercepted on the third leaf above the ear-leaf increased during this stage. The increased PAR interception at this layer was significantly correlated with maize grain yields, suggesting it contributed to the higher yields of the newer hybrids.

The results may facilitate the identification of reliable physiological attributes as selection criteria under declining solar radiation conditions.

### Journal Special Sections

**Agronomy Journal** Features Special Section on Water Security

The July–August issue of *Agronomy Journal* features a special section on “Water Security for Agriculture,” which covers the following topics:

1. Definition of water security
2. Global water resources
3. Water resources and food security
4. Blue water demand for sustainable intensification
5. Managing green water in dryland agriculture
6. Environmental impact of water use in agriculture
7. Towards achieving water security in agriculture
8. Legal constraints on conserving water in the western United States
9. Research and development principles

The papers were prepared by ASA’s Water Security for Agriculture Task Force, which also developed symposia for the AAAS 2013 Annual Meetings in Boston, MA, and the 2013 ASA, CSSA, and SSSA Annual Meeting in Tampa, FL. Visit https://dl.sciencesocieties.org/publications/aj.