A World of Water in Crisis
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FEATURES

5 Addressing the World Water Crisis
Terry A. Howell, Sr.
“... you will find agricultural and biological engineers at the forefront ... ”

COVER STORY
9 Water Scarcity
Aly M. Shady
“... solutions are predicated on vigorous research and development worldwide ... ”

12 Taking Control with Smart Controllers
Michael D. Dukes
Research with automatic irrigation control systems using soil moisture sensors continues to flourish under the Florida sun.

16 Afghan “Ambassador”
Modern-Day Marco Polo
Guy Fipps
Texas A&M prof journals his travel saga, advising a war-torn country on water resources.

20 Addressing U.S. Water Shortage Problems
Blaine Hanson
In light of less and less available H₂O, ASABE members are making a major impact.

22 Conservation/Minimum Tillage in California
John W. Inman
This western U.S. state lags behind in adopting beneficial practices. Why is that?

24 It’s the System for Saving Water!
Gary L. Hawkins, Julia Gaskin, L. Mark Risse
Projected potential savings makes conservation tillage a win-win situation.

DEPARTMENTS

4 From the President
4 Events Calendar
27 Update
28 Personnel Service
29 Index of Advertisers
30 Professional Listings

LAST WORD
31 Drafting Your Words
The world faces a formidable challenge: How can water be provided to meet the world’s ecological and human needs? One-sixth of the world’s population has inadequate access to safe drinking water and many have inadequate water for food production. As populations increase and as unsustainable practices reduce and degrade water supplies, competition for water and the potential for local, national, and international conflicts over water will increase.

Water is a finite natural resource that exists in a constant quantity on the earth. But is that quantity sufficient? The global supply of water is estimated to be 206 billion L (54 billion gal) for each one of the world’s nearly 6.7 billion humans. Unfortunately, 97 percent of this water contains excessive dissolved solids, and without treatment, it is unusable by most plants and animals. This leaves 5 billion L (1.3 billion gal) of fresh water per person. Of that, more than two-thirds is frozen in ice caps and glaciers and not readily available. That still leaves about 1.6 billion L (1.4 billion gal) of fresh surface and groundwater for each person on the planet. Assuming that per capita usage of fresh water is 2 million L (0.5 million gal) per year — an estimate for personal, agricultural, and industrial use in industrialized countries — human needs would require only one-eighth of one percent of the fresh water available.

This suggests there is plenty of water; unfortunately, it is not well distributed, and therein lies the problem. Agricultural and biological engineers have and will continue to provide the engineering to economically and sustainably capture, treat, distribute, and efficiently use available water to meet local needs. However, local supplies are often simply insufficient.

The challenge then is to engineer systems for the sustainable use of a water resource that is sufficient in overall quantity but is lacking in quality and distribution. This challenge must be met to reduce human misery, enhance the environment, and eliminate a major cause of strife. Members of our profession will be at the forefront in developing technology and implementing practices and systems to sustainably manage the world’s water resources to meet human and ecological needs, and this issue of Resource proves just that.

Donald C. Erbach, USDA-ARS (retired)
don.erbach@mac.com

EVENTS

ASABE CONFERENCES AND INTERNATIONAL MEETINGS
To receive more information about ASABE conferences and meetings, call ASABE at (800) 371-2723 or e-mail mcknight@asabe.org

2008
June 27-28 Food Processing Automation Conference. Providence, Rhode Island, USA.
June 29-July 2 ASABE Annual International Meeting. Rhode Island Convention Center, Providence, Rhode Island, USA.
Sept. 1-5 The Eighth International Livestock Environment Symposium (ILES VIII). Iguassu Falls, Brazil.
Nov. 10-13 The ASABE Leadership Experience. Location TBA.

2009
June 28-July 1 ASABE Annual International Meeting. Reno, Nevada, USA.

ASABE SECTION AND COMMUNITY EVENTS

2008
June 12-14 Florida Annual Section Meeting, Trade Show, and Continuing Education Program. Duck Key, Florida, USA. Contact Lisa Collins, Sgators@gmail.com. www.fl-asabe.org.

ASABE ENDORSED EVENTS

2008

2009
More than a billion people lack access to safe drinking water. Two and a half billion people live without access to adequate sanitation systems necessary to reduce exposure to water-related diseases. The failure of the international aid community, nations, and local organizations to satisfy these basic human needs has led to substantial, unnecessary, and preventable human suffering. Tens of thousands of people, mostly young children and the elderly, die every day from water-related diseases.


Safe drinking water and sanitation are just two aspects of the current world water crisis. A broader view includes safe, economical food; sustainable water resources for irrigation and domestic supplies; public protection from natural disasters (drought mitigation, flood protection, etc.); and environmental quality protection and enhancement. Included in all of these are the water resource impacts from global climate change. All of these areas are exactly where you will find agricultural and biological engineers at the forefront of technology, research, education, and training. ASABE members are the leaders in all of these efforts.
**Table 1.** Estimated fractions of available water (in percent) for various agricultural production systems.

<table>
<thead>
<tr>
<th>Category</th>
<th>Irrigated Agriculture</th>
<th>Rainfed Agriculture</th>
<th>Dryland Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total ≈ 1.0 m/yr</td>
<td>&gt;800 mm/yr</td>
<td>&lt;600 mm/yr</td>
</tr>
<tr>
<td></td>
<td>(total ≈ 40 in./year)</td>
<td>(&gt;30 in./year)</td>
<td>(&lt;24 in./year)</td>
</tr>
<tr>
<td>Storage &amp; conveyance</td>
<td>30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Runoff &amp; drainage</td>
<td>15-30</td>
<td>40-50</td>
<td>5-25</td>
</tr>
<tr>
<td>(from soil and water)</td>
<td>10-15</td>
<td>30-35</td>
<td>35-45</td>
</tr>
<tr>
<td>Transpiration</td>
<td>20-35</td>
<td>15-30</td>
<td>10-25</td>
</tr>
</tbody>
</table>


**Getting down to water basics**

Human physiological drinking water requirement estimates vary from 2.5 to 4 L (0.7 to 1.0 gal) per day with an additional 100 L (26.4 gal) per day for sanitation, hygiene, and other household requirements. Peter Gleick notes that the average European water use is 200 to 300 L (50 to 80 gal) per day per person, while the North American water use is approximately 500 L (132.1 gal) per day per person. A Bedouin is estimated to require only 20 L (5 gal) per day.

The major water requirement for human existence is food. Food security is likely at the forefront, but often the water required to grow the crops is neglected or a hidden issue. The world’s population reached six billion on October 12, 1999 and is projected to be expanding at 80 to 85 million per year. The world’s population is projected to expand to between 7.3 and 10.5 billion by 2050 or nearly 14 billion at the current growth rate. Some experts have predicted nearly 67 percent of the world’s population will experience water stress – defined as an annual water volume of less than ~1 ML (264,200 gal) per person – by 2050 about 10 times the current number (~7 percent). That translates into a ratio of one out of six people living with water stress in 2050.

Daniel Renault and ASABE member Wesley Wallender emphasized the need to focus productivity in terms of nutritive value per unit of water rather than just traditional productivity (kg/m³ or pounds/acre/inch) or value ($/m³ or $/acre/ft). They provided an extensive list of the nutritive water productivity of various foods in terms of energy (calories), protein, fat, and calcium.

Food and Agriculture Organization (FAO) of the United Nations uses a basis of 2,700 kcal per person per day for the human nutritive requirement. The values reported by Renault and Wallender varied considerably by commodity or crop. For example, in energy terms the nutritive water productivity varied from 102 kcal/m³ (0.4 kcal/gal) for bovine meat (beef) to 5,626 kcal/m³ (21 kcal/gal) for potato to ~2,000 to 4,000 kcal/m³ (7.6 to 15.1 kcal/gal) for traditional cereal crops (wheat, corn, and rice). One factor in these data is the relatively low fraction of the available water for crop production that is partitioned to transpiration that is the principle driver for carbohydrate production and eventually economic productivity. Table 1 presents my estimates of the fraction of the water supply for irrigated, rainfed, and dryland agricultural systems that are available for crop transpiration that vary from 10 to 35 percent depending mainly on the agricultural production system. These estimates indicate a great potential for both agronomic and engineering improvement.

Population growth will fuel future municipal and industrial water demands. These also provide agricultural and biological engineers unique challenges to treat and utilize the waste water. Beside population growth alone, increased living standards in now less developed parts of the world will increase water demands both for domestic needs but also for higher protein diets. Affluence is largely not addressed internationally, but it is likely to emerge as a major future factor.

**Water is life and energy**

With these population growth rates and increased living standards, the demands for energy will increase. In many areas, even within the United States, the water required in power generation is expected to escalate adding additional demands for water transfers from agriculture to municipal and industrial uses. Even the water requirements for biofuels were estimated by the National Research Council by ASABE member Otto C. Doering III and ASABE fellow E.A. Hiler to raise issues that are regional in the United States on water use but more generally national on water quality, through nutrient transport of N and P and resulting impacts like hypoxia (low dissolved oxygen levels) caused by nutrient pollution and erosion from marginal croplands.
H₂O and future uncertainties
These water conflicts to meet future water demands will further heighten strife between countries as well as the many experienced now between states within the United States as water scarcities become major political issues. Adding to these concerns are the large uncertainties about global climate change impacts on water resources in both quantity and distribution from increasing emissions of CO₂ and other greenhouse gases, particulate matter, etc. In addition, climate variability both temporally and spatially adds major difficulties and increased complexity in the management of water resources.

This year’s drought in the southeastern United States illustrates even in a nation with advanced water management how quickly states and regions can emerge in a water conflict due to differing state legal or regulatory variations. In the author’s home state and city, the only municipal water supply reservoir, Lake Meredith, is at a record low level now. This raises serious hydrologic questions (that many local ASABE members discuss around coffee or the lunch table at work) about public policy. Did the Conservation Reserve Program designed to reduce water and wind erosion from “highly” eroded lands reduce runoff; did the adoption of conservation tillage designed to leave crop residues to protect the soil surface and reduce water and wind erosion cause reduced runoff; or has the increased brush development caused reduced runoff; or did the salt cedar species invasion along the Canadian River reduce river flows by riparian water uptake, etc.? These all simplify to the question, does advanced technology or government policy result in unintended consequences?

Water for the staff of life
Future food needs will require enhanced productivity from irrigated lands, greater production from waterlogged and salinized lands, and more productivity from rainfed and drylands. As the world’s population has increased since the 1960s based on FAO data, irrigated land area has also increased such that the per capita irrigated land has remained relatively stable at about 0.045 ha (0.11 acre) per person. In contrast, arable land area per capita has decreased from 0.38 ha (0.94 acre) per person in 1970 to 0.28 ha (0.69 acre) per person in 1990. Worldwide irrigated land was about 263 Mha (597 million acres) in 1996. Irrigated land comprises 15 percent of the arable land in the world and produces 36 percent of the food. Two-thirds of the world’s irrigated area is in Asia. Prior to 1980, the growth in irrigated area exceeded the population expansion, but since 1980 irrigated land area has declined per capita and is expected to continue to decline as few large scale irrigation developments are being constructed or planned while many areas are experiencing serious issues with ground water declines.

Aqua-color coded
Water is often denoted as “blue water” or “green water” or even as “virtual water.” Blue water is basically the water used or required for domestic, municipal, industrial, environmental, or recreational uses. Green water is generally the water used in crop production and might include the water used in agri-cultural food processing. Virtual water represents the water (either green or blue) required to produce a food or industrial commodity that is imported. As an example, grain exported from the United States to another country can represent a water amount that the importing country will not require for food production; hence their grain import is an export of green water from the United States, making the grain import have a virtual water import value.

Society leads
ASABE members are actively at the forefront on irrigation technology, watershed modeling, water quality modeling, education, and training worldwide. Many U.S. and international ASABE members are actively engaged in research, teaching, and training on international water issues. ASABE is an international leader in the world’s water crisis in its close partnership with the International Commission of Agricultural Engineers (CGIR) as well as other professional organizations.

ASABE member Luis Pereira from ISA, Technical University of Lisbon, Portugal, is the past president of CGIR, active with International Commission on Irrigation and Drainage, and a noted speaker and researcher on water scarcity issues. ASABE member Gerrit Hoogenboom, University of Georgia at Griffith, has developed computer simulation models that have been used extensively during the last 10 to 15 years to predict growth and development and, ultimately, crop yield as a function of local weather and soil conditions and crop management. Hoogenboom has worked with farmers in the African country of Burkina Faso, who like many of their American counterparts, grow sorghum, millet, and corn, but these crops feed humans not animals.
ASABE members James E. Ayars, USDA-ARS, Parlier, Calif., and Eduardo Bautista, USDA-ARS, Maricopa, Ariz.; the author; Dennis Corwin, USDA-ARS, Riverside, Calif.; and Khaled Bali, University of California at Holtville, led a three-day training course on irrigation technology, salinity, water quality, evapotranspiration, and microirrigation for more than 40 scientists from Iraq sponsored by the USDA-Foreign Agricultural Service and U.S. Department of State in Amman, Jordan, in 2007.

ASABE member Steven R. Evett, USDA-ARS, Bushland, Texas, and Ayars are leading an international effort – the Middle East Regional Irrigation Management Information System – as part of the Middle East Peace Initiative (www.merimis.org) bringing together participants from Israel, Jordan, Palestinian Authority, and the United States in one of the most water-scarce regions of the world.

ASABE members are leading a training program, the Indo-U.S. Science and Technology Forum Training School on SWAT (Soil and Water Assessment Tool)/ADAPT (Agricultural Drainage and Pesticide Transport) Modeling for Integrated Water Resource Management, in India and Pakistan. ASABE member Jeffrey Arnold, USDA-ARS, Temple, Texas; ASABE member Prasanna H. Gowda, USDA-ARS, Bushland, Texas; and ASABE member Raghavan Srinivasan, Texas A&M University at College Station, Ashvin K. Gosain, Indian Institute of Technology Delhi, and Sandhya Rao, INRM Consultants, are the principal trainers.

These are just a few of the ASABE members leading the research, education, and training on the world water crisis. Many, many others could be mentioned, particularly on drainage and water quality. Practically every agricultural and biological engineering department or USDA-ARS laboratory with a water emphasis has equally impressive accomplishments that are focused on making water use more productive or effective.

Terry A. Howell, Sr., ASABE Fellow, is research leader and supervisory agricultural engineer, USDA-ARS, Conservation and Production Research Laboratory, Bushland, Texas, USA; terry.howell@ars.usda.gov.

The author wishes to acknowledge as source materials and suggest for further information:


Water Scarcity
Can we live with it?

Aly M. Shady

Fresh water resources are finite. For millions of years, the quantity of fresh water has remained almost constant, about 35 million km$^3$ (8.4 million cubic miles). Of this amount, about 24.0 million km$^3$ (5.7 million cubic miles) are locked up in the form of glacial ice, permafrost, or permanent snow. Ground water and soil moisture account for 10.4 million km$^3$ (2.5 million cubic miles). Freshwater lakes and marshlands hold about 0.09 million km$^3$ (0.02 million cubic miles) accounting for about 0.26 percent of all forms of fresh water with even a smaller portion being accessible for economic use.

—Shiklomanov, 1999

W water is life. All living things depend on water to support life functions. Human and animal food supplies are dependent upon freshwater through agriculture and fisheries. The cultural and spiritual values of water are known to all civilizations and water plays a major role in cultural and recreational activities around the world today.

Mapping the future
For millions of years, both the total quantity of all water resources and the average annual rate of renewal of freshwater resources have remained constant, and for most of recorded history, the finite limit on supplies has remained the same. At the same time, world population continued to grow, and their distribution either outstripped the available fresh water or simply did not coincide with the seeming abundance of fresh water resources. Figure 1 shows the world population growth in 100 years.

With the rise of statehood and restriction-of-people movement, access to water resources closely followed national boundaries. Falkenmark (1989) was one of the first to identify the value of the per capita share of water that defines water scarcity limit.

On average, a water stress condition exists when there is less than 1,700 m$^3$/capita/year (449,140 gal/capita/year) for all major functions (domestic, industrial, agricultural, and natural ecosystems). The stress is a measure of water scarcity where water becomes the main limiting factor for development. One of 12 people currently lives in river basins where they are experiencing water stress or water scarcity. By 2025, about 3 billion people, or nearly 40 percent of the world’s population, could face water scarcity or water stress of some sort. Figure 2 shows the progression of water scarcity worldwide covering the period from 1950 and projected to 2050.
On a global scale, the per capita share shows a very healthy situation; however, this masks the regional and national disparities in accessing these available resources whether on a spatial and temporal basis (see Figure 3).

Water use has accelerated in the recent history. During the 20th century, the world population tripled while water use for human purposes multiplied sixfold (see Figure 4). Of the world’s annual renewable water resources, 71 percent is used for agriculture, 20 percent for industry, and 9 percent for municipal and domestic purposes (see Figure 5).

**Irrigation ...**

is the most visible form of water use, especially in the arid and semi-arid climates. It is practiced on about 17 percent of all agricultural lands worldwide and accounts for about 40 percent of all agricultural outputs. Rain-fed and irrigated agriculture would have to continue to grow at about 2 percent per annum in order to meet the rapid population growth, changes of diet, and newly emerging fuel shortage for transport vehicles. New ways and higher efficiencies for using water in agriculture will be needed to meet the needs for food, fiber, feed, and fuels in the next few decades.

The solutions do not follow a simple pattern. It will take the cooperation of many disciplines and across many divides around the world.

**Improved technology ...**

for water storage, transfer, and conveyance is needed to overcome climatic variation and crop needs. Field application measures to raise efficiency must continue to be developed. A new breed of plants to replace current ones with less water requirement has to evolve rapidly. Post-harvest losses in the fields, storage, and food processing have to be reduced progressively. Food trade and retailing practices need to change to favor practices aimed at reduction of wasteful consumption and more environmental conservation. The poor and rich alike need food as much as they
need water. Accessibility and affordability of these two main life essentials have to be taken into consideration in developing and using all technological advances.

There is enough …

yes, enough water for everyone on the planet. The trick is how to get it and make it available for every use and every user. There is a water infrastructures deficit worldwide, resulting from reluctance to make public investment in such facilities as dams, reservoirs, new irrigation canals, flood control works, and water and waste water treatment plants. This was driven by a general obsession with everything that is “engineered” and the adoption of strict dogma of market economy, which assumed “if there is a market for it, the private sector will do it.” This did not materialize as far as water infrastructure was concerned. The call is out to invest and increase public support to repair dilapidated structures and build new ones where economics and environmental conditions warrant.

The best of technology and growth of investment will have to go through the climatic changes paradigm. Continual adjustment and adaptation have to be found to meet challenges in a timely fashion. We know with certainty that precipitation and evapo-transpiration patterns will not be the same under the current “business as usual” scenario of carbon emission. Successes and failures in controlling greenhouse gases’ emission will have to be factored in the technology and investments needed to ensure adequate supplies of food, fiber, feed, and fuel for the world.

These solutions are predicated on vigorous research and development worldwide. Changes in the educational system will also be needed to provide graduates with new tools to solve the problems of today and tomorrow in a more holistic approach.

ASABE member Aly M. Shady is a senior policy advisor with Canadian International Development Agency, Gatineau, Quebec, Canada; aly_shady@acdi-cida.gc.ca.

Selected sources recommended by the author:
High-value crops, such as vegetables, are nearly always irrigated to ensure optimum yield, and in many areas of the United States, urban landscapes are irrigated as well. In Florida, vegetable production accounts for 89,000 ha (219,000 acres), and it is estimated that there are 1.2 million ha (3 million acres) of managed residential turfgrass.

All vegetable production areas are irrigated, and the majority of turfgrass and landscapes are irrigated. Vegetable crops are estimated to account for 10 percent of agricultural water use, while landscape irrigation is estimated to account for more than half of public supply water use; combined, these two types of irrigation account for 20 percent of the water used in Florida.

Over the past several years, University of Florida (UF) staff and students have been conducting research on automatic irrigation control systems using soil moisture sensors (SMS) on landscape and drip irrigated vegetables as well as controllers using climate data to

Bernard Cardenas-Lailhacar, a UF research associate, and graduate student Mary Shedd, install a soil moisture sensor for irrigation control on St. Augustine grass at the UF Plant Science Research and Education Unit.

Michael D. Dukes
estimate plant evapotranspiration (ET) for landscape irrigation scheduling. These “smart controllers” differ from traditional time clocks since they receive feedback on irrigation needs from the irrigated systems allowing them to adjust to varying plant or climatic needs.

By 2060, it is estimated that nearly one third of agricultural land in Florida will be converted into urban developed land, doubling the current amount of urbanized area. Practically all new construction in urbanizing areas includes high-value irrigated landscapes. In fact, the turfgrass industry in Florida adds $7.3 billion per year to the state economy. In previous work, the UF research team found that homeowners in Central Florida over-irrigate by as much as two to three times the amount needed in the landscape, and that simply adjusting time-clock run times according to historical net irrigation demand can result in 30 percent applied water reduction. Inefficient landscape-irrigation practices exacerbate water supply problems throughout the state.

Successful launch, continued study

In 2004, study of soil moisture irrigation control systems for residential irrigation began. Initial work was described in the June/July 2005 issue of Resource. Since that time, the first phase of the study has been completed, and using SMS controllers resulted in average irrigation savings of 72 percent or 1,094 mm (43 in.) over a ten-month study period. In 2006, a new phase of the residential SMS study began where SMS controllers were installed on existing homes in Pinellas County, Fla. When compared to homes without irrigation control modification, the SMS homes brought in 53 percent irrigation savings in eight months. Cumulative irrigation application was reduced from 250 to 117 mm (10 to 4.6 in.) during relatively dry weather. Thus, initial savings from the use of SMS irrigation controllers appears to be very promising with potential payback ranging from one to three years.

There are a number of unknowns involved in the use of the technology, however. The level of installer training and follow-up necessary to ensure irrigation-savings potential are still unknowns. There have been at least two examples of implementation of the technology in Florida that have failed or nearly failed due to lack of contractor education on the

Evapotranspiration test plots at the UF Gulf Coast Research and Education Center include a mixed landscape of ornamentals and turf grass.
technology and lack of follow-up and documentation of the water savings. As a result, training programs for contractors, builders, developers, and other interested parties are being developed to aid in the successful adoption of the technology.

Another “smart” irrigation technology is climate-based controllers, or “ET” controllers. These controllers have been available for residential and commercial applications for several years in California and Texas as well as in a number of other western states. More recently, they have become available in the eastern United States. Testing of three brands of ET controllers on mixed landscape plots at the UF Gulf Coast Research and Education Center in Hillsborough County began in 2006 and is ongoing. The specific method of irrigation scheduling varies by controller brand, but there are three general approaches: 1) signal-based, 2) on-site measurement, and 3) historical ET-based.

Signal-based controllers receive a signal that typically consists of reference ET (ETo) for the previous day, or they receive information to calculate the ETo for the previous day. On-site measurement controllers, on the other hand, use sensors connected to the controller to gather weather parameters used to estimate ETo. Finally, historical-based ET controllers are pre-programmed with a database of historical mean ET values. Most of the controllers maintain a theoretical balance of moisture content in the soil and then schedule irrigation when allowable depletion levels have occurred. On the other hand, some of the controllers simply replaced the accumulated crop ET on the next allowed watering window. Preliminary results have shown irrigation savings of 9 to 59 percent under dry conditions.

**Sensing vegetable water needs**

Florida vegetable production area ranks fourth in the United States and...
Saving $$$ and water

UF Staff has developed an inexpensive soil moisture controller ($64 U.S.) that can be paired with off-the-shelf soil moisture sensors. In addition, SMS irrigation controllers intended for residential application have been used for irrigation control in our vegetable irrigation research. Soil moisture irrigation controllers have been used in a bypass configuration to control irrigation windows of up to five irrigation events per day on plastic mulched, drip-irrigated vegetables. In bypass configuration, SMS controllers allow predetermined irrigation windows programmed in a time clock only if the soil moisture content at the start of the event is less than a preset threshold.

This research has shown that small and frequent irrigation events as controlled by the soil moisture sensor systems reduce irrigation application 74 to 79 percent compared to fixed-time irrigation on tomato, 37 to 66 percent on green bell pepper, and 33 to 80 percent on zucchini squash. In all cases, marketable yield was unaffected or increased due to better water management. Typical grower practices of fewer and longer irrigation events each day lead to excessive leaching of water on highly porous soils used for vegetable production in Florida. Vegetable SMS irrigation control that is properly set has a $1 billion cash value. Drip irrigation has become an important technique in vegetable production over the past 20 years. Although this form of irrigation can be very efficient by targeting water application to the root zone of the crops, good management is essential to ensure efficiency. Growers often irrigate on fixed time schedules that may or may not be based on plant-growth stage.

Continued on page 26
Afghan “Ambassador”

Professor advises war-torn country on water resources

Guy Fipps

It was December 2005. As I boarded a plane at Dulles, headed for Kabul with a diplomatic passport in hand, I felt a little overwhelmed. I had just spent a week in Washington, D.C., in meetings at the U.S. Department of State (State) and the Pentagon, and had been sworn-in in my temporary appointment with State as the Senior Advisor for Water.

Some called me the U.S. “ambassador for water,” and in a lot of ways, I suppose, I was. I lived and worked at the U.S. Embassy in Kabul, Afghanistan, for nine months, reported directly to the U.S. ambassador, and was charged with charting a new course for water policy and aid in this war-torn country.

Little did I know …

… what was in store for me in the long series of flights that took me first to Dubai and then on to Kabul. During my tour, diplomatic status got me access to the highest levels of the Afghan government, but it was my technical expertise and reputation as an agricultural engineer that got me out of Kabul.
In addition to conducting strategic analysis, water planning, and advising for the Afghan government, I was sought out for my technical knowledge by the U.S. Agency for International Development (USAID), the military, and non-governmental organizations (NGOs). With help from the military and the United Nations, I traveled throughout 14 provinces in Afghanistan, examining the country’s water infrastructure, evaluating issues and, finally, recommending solutions.

I worked closely with the Afghan deputy minister for water and the first vice president in developing a strategy and an organizational framework to address the highly contentious issues related to water use, allocations, and development.

Without question, water has the same urgency as security, energy, and roads...

Water is recognized as a key ...

... and usually as the key, to Afghanistan’s future. About 85 percent of the population is involved in irrigation-dependent agriculture, and 98 percent of all water diverted from the rivers is used by agriculture, with 60 percent or more of that water lost to seepage and poor on-farm efficiency. In addition, irrigation canal systems also provide drinking water to the vast majority of the population.

After 20 years of war, Soviet occupation, and then Taliban rule, what little water infrastructure for irrigation and domestic drinking water the country had was destroyed or had deteriorated. Only 30 percent of the irrigation infrastructure is functioning, and modern domestic water supply and waste treatment systems do not exist.

Without question, water has the same urgency as security, energy, and roads (the key elements of the U.S. efforts in Afghanistan), and water is even more critical to the long-term stability and economic development of the country. Without effective programs, water shortages, internal water conflicts, and international water disputes will increase and become more serious with destabilizing consequences.

The timing of my arrival...

... could not have been more auspicious. State and USAID had just finalized a decision to terminate our water development programs because of failure to produce meaningful results in spite of hundreds of millions of dollars. Thus, I spent my time at the embassy trying to make the case for why the United States needed to be actively engaged in the water sector.

Since the majority of the population is involved in agriculture, improving irrigated agricultural production and livelihoods is critical for maintaining social order. With so many refugees who fled the country during the Soviet occupation and Taliban rule returning, there is need to develop new irrigated farmland for displaced people, some of whom are involved in the insurgency. The thinking is that by getting them back into Afghan society through farming, they will no longer need to seek payment from the insurgency, a view which is held by the U.S. military.

In May 2006, I presented my official water policy assessment to the ambassador and other policymakers in the U.S. mission to Afghanistan. My assessment was that water should be a component of our aid package and concentrated in high priority areas not being addressed by other donors.

My assessment also included nine specific recommendations including rehabilitation of irrigation systems and increasing the water supply, as there is an urgent need for rural residents to see some benefits from the new government. The rural economy and standard of living would improve vastly if the traditional two-crops-per-year system could be reestablished, and that system would reduce the need for farmers to grow poppies.

Another major problem I saw repeatedly when outside of Kabul was the lack of standards for the water infrastructure projects being implemented: poor workmanship, inadequate design, and improper materials resulting in projects that would likely fail within a few years. The United Nations had standards for their projects; thus, we needed a way to get these out to others.

I also spent a lot of time on transboundary water issues due to their potential to impact the long-term stability of the country and region, a policy area that was receiving no attention from State. My biggest success in this area was helping to implement a memorandum of understanding between Afghanistan and neighboring Tajikistan to cooperate on joint development of water resources, such as a large hydro facility on the Amu Daya River. The first step for Afghanistan and the easiest compared to Iran and Pakistan, which were yet to come.

Other threats I identified were rapid and uncontrolled exploration of groundwater, conflicts between up-stream and down-stream water users, the lack of water laws and regulations, and reoccurring droughts. The Embassy itself depends upon groundwater, which was quickly depleting and contaminated in the Kabul Basin.

Some of my best memories ...

... are of spending time with the military. Because of my diplomatic status, I was required to stay at military bases when traveling outside of Kabul. I visited about 12 provincial reconstruction teams
(PRTs), which are military units that provide regional security and fund reconstruction projects.

Because of my engineering background, I was able to help the PRTs in what they were trying to accomplish while they provided me the means to get out and about in the countryside. It is a rather unique experience to be taken out to look at an irrigation project escorted by three to four Humvees and guarded by 10 or more armed soldiers.

It is also amazing how routine wearing body armor and riding around with soldiers can become; I developed a great respect for the military. All Americans should be proud of our young men and women serving in Afghanistan. They are very dedicated and committed to the mission in spite of the tough and dangerous conditions they face.

**I had a heavy heart ...**

... when I left Kabul to return to the United States. I was not sure if I had been successful in changing U.S. policy in water. The last few months at the Embassy were not easy. Some USAID officials were angry with me for questioning the decision to terminate water programs.

Over the next few months, by e-mail and telephone, I continued to advise PRTs on projects, arranged a shipment of polypipe to the 10th Mountain Division for projects in the volatile Khost Province, and helped work out details on the Tajik Memorandum of Understanding with State and the Afghan government.

Then in December 2006, the Afghan government sent a request to the U.S. Ambassador to bring me back to help draft a transboundary water policy for the country. About the same time, USAID contacted me to see if I would be willing to return for a couple of weeks of strategic planning in the water sector.

In April 2007, I found myself once again on a long series of flights to Dubai and on to Kabul for a month back in Afghanistan. The Ambassador sent me an e-mail just before I left, saying how glad he was that I was returning.

It was strange to go back to the U.S. Embassy where I had spent so many months living and working: an armed compound surrounded by 10-foot walls topped with barbed wire and guard towers.

**Satisfaction upon return**

Seven out of the nine recommendations I presented during my water sector assessment the previous year had been implemented! Looking back, I feel humbled that I was asked to go to Afghanistan and am honored to have served my county.

The memories of riding in armored vehicles, going out on missions being escorted by soldiers, and staying on military bases is something that will never leave me. The warmth of the Afghan people and the sheer beauty of the country also fill my reminiscences.

There is no doubt that my eventual success in Afghanistan was due to my background and experience as an agricultural engineer, a profession that has taught me how to solve problems by getting out and assessing a situation. The diplomatic passport got me in the door, but my technical background helped establish credibility and, just as important, got me out of Kabul.

"The body armor and helmet were mine, but the gun wasn't," says Fipps. "The soldiers who were taking me out on the mission that day had me pose with the gun. My staff likes the photo, and they joke about posting in the office with a caption, 'Get the job done!' The other caption that was used around the embassy in Kabul was ‘Water is NOT a four letter word,’ in reference to the static I was getting from USAID on my recommendations.”

ASABE member **Guy Fipps** is a Texas A&M professor and extension agricultural engineer and director of the Irrigation Technology Center, College Station, Texas, USA; g-fipps@tamu.edu.
“Kunduz is the capital of Kunduz Province in Northern Afghanistan, a regional center surrounded by vast expanses of agricultural land. Every trip out is eye-opening, but in Kunduz, I saw something really extraordinary: the construction of an irrigation diversion dike using methods and materials that have not changed for centuries, maybe for thousands of years....

For thousands of years people have lived along the rivers of what is now Afghanistan and diverted water into hand-dug canals to irrigate their crops. Taking advantage of the mountains and slopes, a single canal can run many miles and provide water to many villages, tens of thousands of people, and large irrigated areas.

Afghans construct earthen dikes extending out into the river to divert water. Unfortunately, these dikes frequently wash out when the rivers rise in the spring and early summer as the melting of the mountain snow accelerates. It is the snow that falls in winter that gives water and life to this arid land.

Such was the case of the Kunduz canal. Just three days ago, a weekend rainstorm caused the river to rise high enough to completely wash out the existing diversion dike. Now, very little water is flowing into their canal, and approximately 20,000 families cannot irrigate their crops. It’s early in the growing season; plants are short and cannot go more than a week without water. As of today, the local farmers have only five days to get the dike rebuilt before facing the danger of crop failure.

“We’re amazed at the size of the operation: approximately 400 men and adolescents hard at work. And what an operation it is. The men are divided into several different work crews. One crew digs up large dirt clogs topped with grass, each weighing around 50 pounds. The Afghans hope that the grass will take root and help hold the dikes together.

A group of men are busy weaving ropes from a thick straw that looks like dried water reeds. Some of these ropes are used by the men to cradle the dirt clogs on their backs. A group of men lift the dirt clogs and help secure them on the backs of the workers who then carry them to the river and wade out into the moving water to drop them onto the expanding dike. Layers of clogs and straw are built up, and the dike is extended farther into the river.

“There are lots of disadvantages to these structures,” Fipps said. “They wash out two or three times a year, and they don’t provide good control of water. It’s a big strain on their subsistence economy to take the time to rebuild the dikes. But they work.”

It’s a long walk from the clog piles; to the left is the Kunduz canal seen flowing alongside the river.

The dike quickly begins to form.

Thick reed is woven into ropes.
Irrigated agriculture produces nearly half of the value of crops in the United States on 16 percent of the harvested land. In some cases, nearly all of the production of crops, such as processing tomatoes, almonds, and some vegetables, comes from irrigated land. Yet, irrigated agriculture faces declining water supplies throughout most of the major irrigated areas in the nation.

Drought in many areas of the country has reduced water supplies. In other areas, such as the Midwest, declining groundwater levels have reduced pumping rates and increased energy cost, making irrigation more expensive. Another contributor to the decrease in supplies is the increased demand from the urban and environmental sectors, where in some areas, water initially allocated to agriculture is now allocated for environmental concerns. Fallowing of agricultural land is promoted as a means of supplying more water for urban/environmental uses. Thus, irrigated agriculture is challenged with finding ways to maintain the production of food and fiber with less water.

ASABE members instrumental in meeting California’s challenge

In California, where urban/environmental water demands are reducing agricultural water supplies, ASABE members are improving the crop coefficients used in estimating crop evapotranspiration for short-season vegetable crops like lettuce, garlic, broccoli, peppers, and onions. The effect of the irrigation method on the amount of water applied is also being studied for these crops.

Other studies have addressed or are addressing improved crop coefficients for processing tomatoes and alfalfa. A technique of regulated deficit irrigation (RDI) of wine grapes is being promoted and has a potential of reducing water use by about 30 percent. RDI involves withholding water from the plants at certain stages of growth. In addition to the reduced water use, improved wine grape quality is also a benefit. A manual for irrigators on this strategy is near completion.

ASABE members are also involved in publishing a series of manuals designed for irrigators on irrigation water management covering topics such as irrigation scheduling, microirrigation of trees and vines, soil water monitoring, chemigation and fertigation, and maintenance of microirrigation systems. In addition, midsummer deficit irrigation of alfalfa, a major user of water in California, is being investigated as a strategy for providing additional water to water-short areas. Also, past research by ASABE members showed that subsurface drip irrigation of processing tomatoes is highly profitable compared to other irrigation methods in the salt-affected soil along the west side of the San Joaquin Valley, a water-short area.
Other research by ASABE members on irrigation systems compared subsurface drip irrigation, spray center-pivot systems, and low-energy precise application systems. Precision mobile drip irrigation (center pivots equipped with drip lines) was also compared with the traditional spray center-pivot systems.

ASABE members in Midwest areas also have investigated irrigation management strategies under deficit irrigation conditions on crop production of corn, cotton, sorghum, wheat, and soybean as a means for coping with reduced pumping capacities. These studies evaluated the effect of full irrigation on yield and income versus limited irrigation water applied throughout the crop season and also applied at various stages of growth.

ASABE members have also been instrumental in organizing and conducting the annual Central Plains Irrigation Conference and Exposition.

Florida and Arizona: Urban greening by clock and drip

The increased demand for water by the urban sectors in Florida and Arizona has resulted in ASABE members addressing urban water use in addition to agricultural water use. Both research and educational programs on using soil water sensors to automate irrigation can reduce water applications by 60 to 90 percent for tropical fruit and ornamental crops in Florida. Research in Florida revealed that homeowners easily applied irrigation water at rates of two to three times more than needed by the plants, but that time clocks used to set irrigation times can result in 30 percent less water used. Also in Florida, a water conservation clearing house has been developed that makes available to interested individuals and agencies technical reports, published journal papers, and educational outreach information on the water issues facing the state.

In Arizona, one particularly interesting project focused on improving drip irrigation in the Phoenix metropolitan area. ASABE members also developed and implemented the Arizona Irrigation Scheduling Systems to better help water users determine crop water use for irrigation scheduling. A demonstration project was conducted to evaluate the use of subsurface drip irrigation on the vegetable crops grown in Arizona.

In the Southeast, ASABE members have been dealing with drought conditions for several years and have developed educational materials, which address efficient urban use of water. A focus has been on site-specific irrigation and subsurface drip irrigation, which not only involves research efforts but also developing a series of publications tailored to the site-specific needs of the various states.

Information is (water) power

Many ASABE members contributed to the recent publication, *Microirrigation for Crop Production*, edited by ASABE members Freddie Lamm, James Ayars, and Francis Nakayama, and published by Elsevier. This book contains up-to-date information on design principles, types of microirrigation systems and their design and management, soil water concepts, irrigation scheduling, salinity, economics, operation and maintenance, chemigation and fertigation, and system evaluation.

Serious water issues exist in many areas of the United States that will require or are requiring major changes in the irrigation practices of both agriculture and urban sectors. As can been seen in this overview, ASABE members are actively involved in conducting research and educational programs designed to address and implement the needed changes.

ASABE member Blaine Hanson serves the University of California, Davis Department of Land, Air, and Water Resources as an irrigation and drainage specialist; brhanson@ucdavis.edu.
Conservation/Minimum Tillage in California

John W. Inman

Conservation tillage has not been a widely used practice in California agriculture. In 2004, estimates indicated that only 0.3 percent of agricultural land in California used conservation tillage. If minimum tillage is added, the percentage goes up to 0.5 percent. A study in 2006 indicated that the acreage using these tillage practices had doubled. Considering that the estimates are that 30 percent of the land in the rest of the country uses conservation or minimum tillage, California agriculture is still lagging behind the rest of the country in adopting these practices.

Conditions account for lag

Certainly some of this lag is because the conditions in California agriculture are much different than in the Midwest and other areas where conservation and/or minimum tillage are common practices. Since most of California agriculture is on level irrigated soils, erosion is not a major issue as it is in other areas of the country. Furthermore, a number of crops, such as vegetables and processing tomatoes, require good, raised seedbeds to obtain proper stands and, prior to this time, it has been difficult to create an adequate seedbed for these crops utilizing conservation or minimum tillage.

These machines have multiple tillage implements in a single machine. On the left is the Optimizer manufactured by Tillage International; the Wilcox Eliminator from Wilcox Agri-Products is shown on the right.

Machines rework old vegetable beds to prepare them for the next crop. The unit on the left is a Hahn made by Hahn Tractor, and the unit on the right is a Wilcox Performer from Wilcox Agri-Products. The state-proud author notes that all four machines shown on this page are built in California.
Rising costs of production are forcing California growers to look at practices to reduce tillage costs in a number of crops. Additionally, California’s San Joaquin Valley has one of the worse air pollution problems in the United States, and agriculture is part of that problem. A significant air pollutant is dust from agricultural operations, and growers have to reduce dust. In the worst areas, growers must file an annual plan showing how they are going to reduce air pollution. Conservation tillage has two advantages since it reduces the number of tillage trips through the field, thus reducing both dust and engine exhaust emissions.

**Easing the cost**

In some areas of the valley, the Natural Resources Conservation Service (NRCS) has cost share programs directed at reducing air pollution. The NRCS cost sharing can be up to $30 per 0.4 ha (1 acre) per year for up to three years with a maximum of 404.7 ha (1,000 acres) per grower. This cost sharing can help growers buy new equipment required for conservation tillage.

**California remains a novelty**

Other issues make the California situation unique. For example, with the exception of cotton and corn, so-called Round Up ready crops are not grown in California, thus requiring a different approach to weed control when compared to the Midwest and southeastern areas of the country. In some cases where conservation tillage has been used in California, there has been a shift in weed types as perennial weeds increased and annual weeds decreased. Weed control may be a limiting factor for conservation tillage in some California crops.

Jeff Mitchell, University of California Cooperative Extension specialist, has had a research program on conservation tillage for a number of years and, as indicated by the numbers cited earlier, more California growers are using conservation or minimum tillage practices and significantly reducing tillage costs.

Fred Leavitt of Sun Pacific Farming in Exeter, Calif., has reduced the amount of fuel used for tillage in fresh market tomatoes by 41 L (11 gal) per 0.4 ha (1 acre). Israel Morales of American Farms in Salinas, Calif., has reduced tillage operations between vegetable crops to six passes through the field, compared to 12 or more passes by a neighboring grower who uses conventional tillage techniques.

California crops and field conditions require different equipment for conservation tillage. There are two approaches to equipment for minimum tillage in California. One uses tillage equipment that has multiple tillage elements in a single machine to reduce the number of passes through the field needed to prepare a seedbed. The other approach is to rework beds that have been used to grow tomatoes or other vegetables using specialized equipment for the next crop.

Both of these types of equipment are becoming available from both California and national farm equipment manufacturers. As cost and regulatory pressures increase, conservation tillage will become an increasingly common practice in California.

ASABE member **John W. Inman** is an agricultural consultant and farm advisor, agricultural engineering, emeritus, University of California Cooperative Extension Service; jwinman@comcast.net.

The author snapped these pictures at a strip till field day in late spring near Stockton, Calif. An Orthman one-trip strip tillage machine, *left*, and a Monosem planter, *right*, were captured on film planting corn in the previously tilled strips. “Neither of these units are made in California,” says Inman.
The drought in the southeastern United States over the past two years has made national news. In some areas of Alabama, Georgia, and Florida, surface and ground water sources are still stressed, and farmers are being asked to cut their usage of irrigation water. One approach to conserving water is conservation tillage systems.

Conservation tillage systems plant the summer cash crop directly into a killed winter cover crop with minimal or no tillage. Research has shown the combination of reduced tillage and the use of cover crops increases infiltration rates by as much as 35 to 40 percent compared to conventional tillage for loamy sand and sandy loam soils.

Projected potential savings

Based on 2004 data, potential water savings for Georgia at the current adoption rate of conservation tillage systems (approximately 30 percent) are 16.7 billion L (4.4 billion gal) annually in the 0.5 million ha (1.3 million acres) of cotton planted. Similar estimates for corn and peanuts acres are
1.2 and 3.8 billion L (0.33 and 1.0 billion gal) annually. This amount of water is equivalent to three months of the water use in Atlanta, Georgia, (based on average daily consumption). These potential savings calculations were based on work done by USDA-ARS indicating an additional two to three days of water was available for crops in the soil profile of fields in a conservation tillage system compared to conventional tillage.

The higher infiltration rates on conservation tillage system fields make better use of the natural rainfall and also typically reduce the number of passes needed by irrigation equipment. This represents an additional savings in energy costs for the farmer.

A win-win saving situation

Conservation tillage systems affect infiltration rates by increasing crop residue and soil organic matter at the soil surface. The loamy sands and sandy loams of the southeastern U.S. Coastal Plain are low in soil organic matter and prone to crusting with conventional tillage. The increased residue reduces the energy of raindrops hitting the soil surface and helps prevent detachment of small soil particles that plug soil pores at the surface. The increase in soil organic matter promotes the formation of water stable aggregates that resist the impact of raindrops and keep surface soil pores open.

Research has shown that in the hot and humid climate of the southeastern United States reducing tillage and using cover crops are important for increasing soil organic matter. Tillage adds oxygen to the soil and increases microbial activity, which accelerates the decomposition of soil organic matter. Cover crops add organic matter to the soil, both in the belowground root biomass and as residue aboveground. The residue acts as a mulch and slowly breaks down over the growing season. The key is adding more organic matter than is decomposed over the year. Studies have shown that about 1.3 tons/ha (1.5 tons/acre) of biomass is needed to maintain soil organic matter and 3.6 to 4.5 tons/ha (4 to 5 tons/acre) of biomass is needed to increase soil organic matter in the Southeast.

One caveat for water use is that an actively growing cover crop can deplete soil moisture during dry spring seasons. Farmers need to monitor soil moisture closely and terminate the cover crop at least three weeks before planting to give rains a chance to replenish soil moisture.

Saving for a rainy day

As annual precipitation in the southeast has been below average the past couple years, farmers are being asked to conserve water. In addition to other irrigation conservation measures, conservation tillage systems can save water by increasing the infiltration rate and water holding capacity, providing good stewardship of both soil and water resources.

In Georgia, the legislature has adopted a new statewide water plan. This plan calls on agriculture to invest in irrigation conservation measures and to adopt conservation tillage systems as a water conservation measure. This proactive approach of encouraging conservation of soil and water resources could prove useful in other states with similar resource concerns.

The work is very hard and demanding; it must be extremely difficult, first carrying a large load of dirt on your back, and then wading though the water with the thick under footing of river bottom silt ...

We watch as the dike quickly forms and extends farther into the river. Such a massive and organized operation is amazing and fascinating to see. Each farmer along the canal contributed labor or money proportionally to the size of his land.

I watch as the straw-men make huge rectangular bales of dried reeds held together by the thick ropes of woven straw. Finally, their purpose becomes clear. As the dike is constructed, gaps are left in the dike in order to reduce the pressure and erosion caused by the moving water in the river. It takes 20 men to roll the huge bales into the river and to float them out to the dike to plug these gaps. Dirt clogs are then layered on the straw bales to complete the dike.

The dike will wash out a few times a year, taking money and labor away from cultivation and harvesting of crops, further hurting the subsistence agriculture of the region.

Three weeks later …

I visited the site. The dike is still standing even though the river has already risen a foot since my last visit. The dike is working perfectly and diverts large amounts of water into the canal.”

TAKING CONTROL WITH SMART CONTROLLERS

up allows irrigation to closely follow crop ET. Better management of irrigation water in the root zone also leads to better management of soluble chemicals such as nitrate nitrogen. Excessive water often leads to leaching of nitrate in these soils. We have also shown that leachate volume and nitrogen percolate below the root zone have been reduced due to SMS irrigation control. Similar to the residential irrigation controller research, the next step with the vegetable irrigation research is to implement and demonstrate SMS automatic irrigation control on commercial farms.

ASABE member Michael D. Dukes is an associate professor, University of Florida Agricultural and Biological Engineering Department, Gainesville, Florida, USA; mddukes@ufl.edu.

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Are existing large-scale simulations of water dynamics wrong?

In the February issue of Vadose Zone Journal, researchers find that a much smaller spatial resolution should be used for modeling soil water.

Soils are complicated porous media that are highly relevant for the sustainable use of water resources. Not only the essential basis for agriculture, soils also act as a filter for clean drinking water, and, depending on soil properties, they dampen or intensify surface runoff and thus susceptibility to floods. Moreover, the interaction of soil water with the atmosphere and the related energy flux is an important part of modern weather and climate models.

An accurate modeling of soil water dynamics thus has been an important research challenge for decades, but the prediction of water movement, especially at large spatial scales, is complicated by the heterogeneity of soils and the sometimes-complicated topography.

Simulation models are typically based on Richards’ equation, a nonlinear partial differential equation, which can be solved using numerical solution methods. A prerequisite of most solution algorithms is the partitioning of the simulated region into discrete grid cells. For any fixed region, such as a soil profile, a hill slope, or an entire watershed, the grid resolution is usually limited by the available computer power. But how does this grid resolution affect the quality of the solution?

This problem was explored by Hans-Joerg Vogel from the UFZ - Helmholtz Center of Environmental Research in Leipzig, Germany, and Olaf Ippisch from the Institute for Parallel and Distributed Systems of the University of Stuttgart, Germany. Vogel and Ippisch found that the critical limit for the spatial resolution can be estimated based on more easily available soil properties: the soil water retention characteristic. Most importantly, this limit came out to be on the order of decimeters for loamy soils and is even lower, on the order of millimeters, for sandy soils. This is much smaller than the resolution used in many practical applications.

This study implies that large-scale simulations of water dynamics in soil may be imprecise to completely wrong. But, it also opens new options for a specific refinement of simulation techniques using locally adaptive grids. The derived critical limit could serve as an indicator that shows where a refinement is necessary. These findings should be transferable to applications such as the simulation of oil reservoirs or models for soil remediation techniques.

For more information contact Sara Uttech, Soil Science Society of America, 608-268-4948, suttechsoils.org.

New Technologies to Protect Natural Resources

New tools created by scientists with the Agricultural Research Service (ARS) in collaboration with the Natural Resources Conservation Service (NRCS) will help keep the environment healthy by streamlining the process of developing computer models and decision-support tools used by agricultural producers and others in natural resource analysis and conservation planning.

ARS is the chief scientific research agency of the U.S. Department of Agriculture (USDA). NRCS – also part of USDA – leads national conservation of soil, water, air, and other natural resources on private land.

One of the new technologies is the Object-Modeling System (OMS), which serves as a framework for streamlining the development, integration, use and maintenance of disparate computer simulation modules and tools built around hydrological, erosion, climate, crop-growth and other agricultural research data.

Scientists developed OMS with ARS’s Agricultural Systems Research Unit in Fort Collins, Colo., in collaboration with the NRCS Information Technology Center and the U.S. Geological Survey.

The second new tool is an updated and field-tested version of the Wind-Erosion Prediction System (WEPS). This computer program will equip NRCS field personnel with a cutting-edge tool for calculating topsoil losses caused by wind erosion, especially in drought-prone regions of the country such as the Great Plains, where some 5 million acres are at risk. WEPS will also allow users to model how such losses could be avoided or reduced by implementing a given erosion-control measure, such as planting cover crops, using conservation tillage or establishing wind buffers.

WEPS is the result of 16 years of collaboration between ARS and NRCS software engineers and scientists. The updated version includes changes incorporated after three years of field testing, NRCS feedback, and fine-tuning to make WEPS even more user-friendly.

Since its inception in the 1930s, NRCS’ conservation delivery system continues a unique partnership, delivering conservation that respects local needs, while accommodating state and national interests. For more information about NRCS, visit its Web site at www.nrcs.usda.gov.

For more information contact the author, public affairs specialist Jan Suszkiw, 301-504-1630, Jan. Suszkiw@ars.usda.gov, and/or visit www.ars.usda.gov/AboutUs/
**ASSOCIATE DEAN OF THE AGRICULTURAL RESEARCH DIVISION AND ASSOCIATE DIRECTOR OF THE NEBRASKA AGRICULTURAL EXPERIMENT STATION INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES UNIVERSITY OF NEBRASKA-LINCOLN**

The University of Nebraska-Lincoln Institute of Agriculture and Natural Resources (IANR) invites applications for the Associate Dean of the Agricultural Research Division (ARD) and Associate Director of the Nebraska Agricultural Experiment Station (NAES). This position is an excellent opportunity for a highly motivated individual to provide innovative and visionary leadership as an integral part of the administrative team at the state, regional and national levels. Interested parties are encouraged to review http://ard.unl.edu for more specific information on ARD and its activities.

**Requirements:** Doctoral degree, or comparable terminal degree, required; successful candidate must be able to meet qualifications for the rank of full professor with tenure, in an academic unit affiliated with IANR. The successful candidate must be able to provide a demonstrated record of significant and successful administrative and academic achievement at a research university or equivalent experience in government or industry.

**To apply for this position:** Access http://employment.unl.edu and search for requisition # 080008, Associate Dean, Agricultural Research Division, and Associate Director, NE Agricultural Experiment Station. Complete the faculty academic administrative information form; attach a letter of application, curriculum vitae and contact information (mailing address, phone number and e-mail address if available) for three professional references. Review of applications will begin Monday, April 21, 2008, and will continue until the position is filled.

*The University of Nebraska-Lincoln is committed to a pluralistic campus community through affirmative action and equal opportunity and is responsive to the needs of dual career couples. We assure accommodation under the Americans with Disabilities Act; contact Linda Arnold at 402/472-3802 for assistance.*

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**Requirements:** Applicants must have earned a Ph. D. in Agricultural Systems Management, Agricultural Engineering, Biological Systems Engineering, Industrial Engineering, or a closely related field. A strong commitment to teaching and research; excellent communications skills; ability and desire to work cooperatively on multi-disciplinary teaching and research projects; and knowledge of utilizing biological materials for energy production is required.

Contact: Ronald E. Yoder, Ph. D., P. E., University of Nebraska 223 L. W. Chase Hall, P. O. Box 830726 Lincoln, NE 68583-0726 Voice: 402.472.1413, FAX: 402.472.6338, http://bse.unl.edu

**How to apply:** To be considered for this position go to http://employment.unl.edu, requisition 080096 and complete the Faculty/Academic Administrative form and attach required documents.

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ASSISTANT/ASSOCIATE PROFESSOR (FOOD AND PROCESSING ENGINEERING TECHNOLOGY), PLANT, SOIL AND AGRICULTURAL SYSTEMS, AT SOUTHERN ILLINOIS UNIVERSITY-CARBONDALE

Position available August 16, 2008

Qualifications: Earned doctorate by the time of appointment in agricultural systems, agricultural operations management, agricultural engineering technology, agricultural engineering, food science, packaging science, or a closely related technology or engineering field; and 2) Demonstrated effectiveness in oral and written communication. Preference will be given to candidates with: 1) Demonstrated expertise in instrumentation and automation, 2) Experience in college level teaching appropriate to the teaching assignment; 3) Ability to teach CAD, agricultural processing, automation, food engineering technology, and operations management; 4) Professional work experience in industry or academia; and 5) Strong skills in computing, electronics, and programming. To qualify for appointment as Associate Professor, the successful candidate must have developed a nationally-recognized research program, demonstrated continued success in competitive grant support at all levels, and show a strong record of sustained publication in peer-reviewed journals.

Responsibilities: The successful candidate will teach courses in the undergraduate food and process engineering technology and agricultural systems technology specializations, selected from CAD, processing, automation, food engineering technology, operations management, or others according to program needs. The successful candidate will develop a research program leading toward grants and refereed publications. The faculty member will also advise students in undergraduate curricula, special projects, and club activities.

Salary: Salary is commensurate with professional experience. A generous benefit package includes sponsored retirement programs (state or self-managed) and health (medical, dental, and vision) programs.

Application and Deadline: Complete application package, as detailed, should arrive by May 31, 2008 for full consideration. Applications will be accepted until position is filled. Applicants must submit a letter of application detailing interest and qualifications, statement of teaching philosophy, list and brief description of courses taught, statement of industry or academic experience related to this position, statement of research interests related to this position, official transcripts, curriculum vitae, and three letters of recommendation specific to this position. Application materials (electronic not acceptable) should be mailed to: Dr. Dennis G. Watson, Search Committee Chair, Department of Plant, Soil and Agricultural Systems, Mail Code 4415 Southern Illinois University, 1205 Lincoln Drive, RM 176, Carbondale, Illinois 62901 (618-453-6979) dwatson@siu.edu.

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RESEARCH ASSOCIATE – GASEOUS EMISSIONS FROM SILAGE AGRICULTURAL ENGINEER/ANIMAL SCIENTIST

USDA/ARS, Pasture Systems and Watershed Management Research Unit, University Park, Pennsylvania (located on The Pennsylvania State University campus) is seeking to fill a full-time, 2-year postdoctoral position. This research assignment will measure emissions of volatile organic compounds (VOCs) from silage and develop relationships that predict daily VOC emissions in the silo, during handling, and in the feed bunk as functions of silage characteristics and environmental conditions.

Requirements. A Ph.D. in Agricultural Engineering, Animal Science, or a related field is required. Experience in laboratory procedures such as feed component analysis or gaseous emission measurement is required and experience with model development and application is desired. Beginning salary for GS-11: $54,494 per annum, plus benefits. Certain citizenship restrictions apply. For further information and complete application instructions, visit http://www.afm.ars.usda.gov/divisions/hrd/hrdhomepage/vacancy/pd962.html and click on RA-08-060-L, or contact Dr. C. Alan Rotz at 814-865-2049, or email: Al.Rotz@ars.usda.gov.

USDA/ARS is an equal opportunity provider and employer.

ASSISTANT/ASSOCIATE PROFESSOR OF AGRICULTURAL ENGINEERING TECHNOLOGY

The Department of Agricultural Engineering Technology at the University of Wisconsin-River Falls is seeking applications for an undergraduate tenure-track teaching position beginning August 2008. Responsibilities include teaching undergraduate courses in a lab setting for the Department of Agricultural Engineering Technology. Applicants with expertise in power and machinery, structure and environment, soil and water, food and processing engineering, or electronics and information systems will be considered.

Qualifications: An M.S. or Ph.D. in Agricultural Engineering, Engineering Technology, Construction Management, or closely related engineering field with demonstrated teaching and/or industry experience is required. Salary range: $60-90K for 9 month position.

Inquiries and applications should be sent to: Dr. Dean Olson, Recruitment Committee Chair, Department of Agricultural Engineering Technology, University of Wisconsin-River Falls, 410 South 3rd Street, River Falls, WI 54022, dean.ivanolson@uwrf.edu. Review of applications will begin on April 15, 2008 and continue until the positions are filled.

Index of Advertisers

Computer Software
Onset Computer Corporation .................................................. 8
Irrometer Company, Inc. .................................................. 26
Lindsay Corporation .......................................................... 14

Controllers
Hortau, Inc. ........................................................................ 15
Naylor, LLC .......................................................... Inside Front Cover
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30 May 2008 RESOURCE
Engineers often receive the stereotype of being number crunchers and problem solvers, not report writers and strong communicators. But the truth is that in the professional engineering world, strong communication skills are essential, especially clear, concise writing.

Unfortunately, I did not find this out until late in my college career, at which point I discovered I was going to need to know how to read and write no matter what field of work I entered. In my past two years in the workforce, I have written more than five times as many reports as I did throughout four-and-a-half years of college.

I have learned that being able to convey information accurately to an audience that often times has not seen or has little experience with the topic being discussed is crucial to job success. Here are some steps to sharpen your writing skills, many of which I used to write this article.

1) **Have someone else proofread your writing.** Spell check is a good start, but having someone read your document is usually most effective. For example, if you mess up homonyms and do not “right the write way,” spell check will not pick up the mistake, whereas a proofreader probably will. Not only will your writing be more professional, but it will be easier for your audience to comprehend.

2) **Keep the language simple and clean.** Punctuation, grammar, and sentence structure are building blocks of delivering effective and direct information. Commas in incorrect places can change the meaning of a sentence. For example: “He was kicked by a cow which annoyed him.” vs. “He was kicked by a cow, which annoyed him.” In the first statement, the cow annoyed him, and in the second, being kicked annoyed him.

3) **Be conscious of language.** While short e-mails with slang language or inter-office jokes are common, it is important to avoid excessive slang and inappropriate content. E-mails have many times become the focus of court cases when information was combined among other items and not clearly stated. You probably don’t want to ask your client when y’all are going to have your next powwow.

4) **Use a manual of style.** Certain publications will often adhere to one style or another. Check out the *Chicago Manual of Style, U.S. Government Printing Office Manual, American Psychological Association (APA)*, or *Modern Language Association of America (MLA)*. For day-to-day business, pick the best fit for you. It is important that everyone involved on a project consistently uses the same style to avoid confusion and conflict over style.

5) **Pick a tense and stick to it.** It will confuse the reader if you interchange between present, past, and future tense. A document written in present tense is typically more immediate and less complicated.

6) **Give credit where credit is due.** Be sure to cite your sources. This is a good idea, particularly when someone else reads your work and wants to know more or where you gathered the information. By citing sources, you avoid any chance of being accused of plagiarism. A manual, as mentioned above, can give guidance on how to properly cite a source.

7) **Define uncommon acronyms and technical terms.** Everyday jargon with acronyms and technical terms you use on a daily basis may not be the same ones others in the industry use. It amazes me every time I’m talking to a farmer and he does not know what the NRCS (Natural Resource Conservation Service) means. If your audience does not know the definition of the term or organization you are discussing, you are not relaying any information to the audience.

8) **Know your audience.** Your audience will determine how you apply the above suggestions. If you are writing for your local newspaper or other general public piece, have a non-engineer proofread what you have written to ensure that it makes sense. If you are writing for a technical journal, ask a colleague or co-worker to read it over and check if your technical conclusions make sense.

If you’re looking for a good place to start, check out some of the following Web sites:

- www.chicagomanualofstyle.org
- www.gpoaccess.gov/stylemanual/browse.html
- apastyle.apa.org
- www.mla.org

ASABE member **Naomi Uhlenhake** is an engineer with Resource Engineering Associates, Madison, Wis., USA, and is the YPC member at large; ncuhlenhake@uwalumni.com.
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