Department of Agricultural and Resource Economics

The Cardon Endowment for Agricultural Economics and Policy

Volume 1, Issue 2
Fall 2003

ArizonaReview
economic perspectives on Arizona's agriculture and natural resources

THE UNIVERSITY OF ARIZONA.

Donald Butler

An Interview with the New Director of the Arizona Department of Agriculture

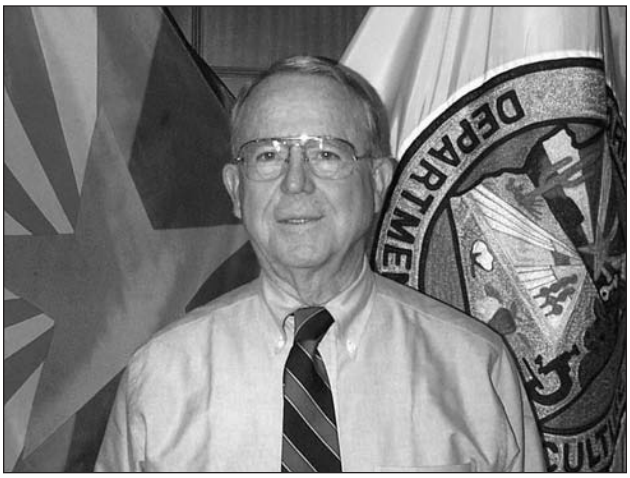
Harry W. Ayer

In early August, Governor Napolitano appointed Donald Butler to be the director of the Arizona Department of Agriculture. Mr. Butler brings more than 50 years of agricultural business experience to the post, and almost as many years of public service.

Mr. Butler received his Bachelor of Science degree in Agriculture from the University of Arizona. During his business career, he served as chairman of Shasta Foods International, Inc., a Japanese-American wholly integrated meat export company based in Gonzales, California. Mr. Butler worked extensively in Arizona's beef industry, buying and marketing cattle; handling livestock loans, appraisals, and related business activities; and culminating in his current ownership of Coronado Cattle Company in Tucson.

Don has been a leading representative of the cattle industry. He is past president of the National Cattlemen's Association, and served for several years as chairman of the National Cattlemen's Foundation. The secretary of the interior appointed Mr. Butler to the National Public Lands Advisory Council and during his tenure Don served a term as chairman. Mr. Butler was appointed by President Ronald Reagan to the President's Advisory Committee for Trade Policy and Negotiations, and was reappointed by President George H. Bush.

Mr. Butler has been active in foreign business affairs through his involvement with the U.S. Meat Export Federation, an organization he chaired and from which he received the Distinguished Service Award. He also served as chairman of the Federal Reserve Bank of San Francisco's Twelfth District Advisory Council and was awarded its Citation for Distinguished Service.



He is a past president of the Arizona Cattle Feeder's Association, the University of Arizona Alumni Association, and the Arizona Agriculture "100" Council.

Don is married to Palmer "Blue" Butler with whom he enjoys his six children and thirteen grandchildren.

I visited with Mr. Butler at the University of Arizona on a recent Friday, early afternoon. He had already completed a breakfast meeting in Phoenix and meetings with University of Arizona administrators on the UA campus. Apparently Friday would not be a slow day for the new director!

Arizona Review. *By way of background, what are some of the key responsibilities of the Arizona Department of Agriculture? How might the Department change under your leadership?*

Butler. The ADA serves both consumer interests and the agricultural sector of Arizona. The consumer is the one buying the agricultural products, and consumers must know that their food is safe. Food safety is my number one priority. The Department must act on

Continued on page 18.

Contents

Volume 1, Issue 2
Fall 2003

Arizona Review
Economic Perspectives on Arizona's Agriculture and Natural Resources

Arizona Review is published biannually, spring and fall, by the Department of Agricultural and Resource Economics at The University of Arizona, and by the Cardon Endowment for Agricultural Economics and Policy, also at The University of Arizona.

Arizona Review is available at
http://ag.arizona.edu/arec/pubs/azreview.html

Editor Harry Ayer
Associate Editor Nancy Bannister
Layout and Design Nancy Bannister

ArizonaReview
economic perspectives on Arizona's agriculture and natural resources

Welcome

to our second issue of the *Arizona Review*. The *Review* is published in the spring and the fall by the Department of Agricultural and Resource Economics and the Bartley P. Cardon Endowment in Agricultural Economics and Policy. Our aim is to provide a practical and reasoned economic perspective on farming and ranching, agribusiness, food, and resource issues. With our spring 2003 edition, we had an overwhelmingly positive response from you.

In this issue, Don Butler, director of the Arizona Department of Agriculture, discusses issues facing Arizona agriculture and the Arizona Department of Agriculture's role. Other articles look at endangered species protection, reducing pesticide use in Arizona cotton, dust mitigation, water management efforts and avoiding crisis, and the economics of doing more with less. In a regular feature, we provide an overview of Arizona's agricultural situation.

There are changes afoot at the Department and the *Review*. We'd like to welcome Dean Lueck who shortly will be assuming the Cardon Chair professorship. He'll be the subject of an interview in the next issue. We also must say good-bye to Harry Ayer, the *Review's* editor. Harry is retiring at the end of the year, and we thank him for getting the *Review* running and wish him well. George Frisvold and Russ Tronstad will be the new co-editors commencing with the spring 2003 issue.

—Alan Ker, Head
Department of Agricultural and Resource Economics
University of Arizona

Doing More With Less

A Doubtful Proposition

Bruce R. Beattie
beattie@u.arizona.edu
Professor
Agricultural and Resource Economics
University of Arizona

Sometimes a little Econ 101 tells us most, if not all, of what we need to know. A case in point is debunking the nonsensical idea that individuals, households, business firms, and other organizations "can do more with less." Regularly we hear ourselves or others suggest that shrinking budgets should get us motivated, make us creative, and before we know it we will be producing and consuming more and be happier than we were previously. This notion is partly, but by no means principally, due to the goofy idea that people respond more creatively to sticks than to carrots. Interestingly, the folks who subscribe to the superiority of incentive by stick do so mainly in reference to what needs to be done to motivate others—not to motivate themselves, their household, their business, or their workplace unit.

All we need to remind ourselves of the foolishness of the "doing more with less" idea is to take down from the attic our dusty old "Principles of Economics" textbook and read three chapters. First, we should reread the chapter that discusses consumer response to increases and decreases in disposable income, in particular the response to a shrinking household budget for purchase of goods and services. Second, we should reread the parallel chapter on producer response to a shrinking budget for purchase of production inputs. And lastly, we should have a look at the chapter that talks about changing (improving) production technology. I'm suggesting that we only reread three chapters because I presume we all remember what was in Chapter 1. That is, surely we recall that incentives matter—all economic participants (individuals, households, business firms, even university professors and deans) ought to and, in fact, do respond to both negative and positive incentives—and self-interest and rational choice are instinctive for all sound-minded persons.

To further expedite this little excursion, I suggest we move directly to the chapter on producer response. We are all consumers and we know from personal experience that we are never happier or able to consume/do more when our income falls. When our incomes decline, our ability to purchase goods and services is diminished; we "get to" consume less, not more; and we darn well aren't happy about it. Despite that, we continue to nod approvingly like some kind of mindless robot when admonished to "do more with less" or to "learn to do more with less" in our work place—in our role as producers. In fact, most of us are so conditioned to the retort that we are often ourselves the admonishers.

We proceed as follows: First, we debunk the idea that producers/business firms "can do more with less." Then we turn to the slightly more involved idea of producers "learning to do more with less."

The Nonsense of Doing More with Less

Suppose it's 1999 and you and your family are in the cookie business, specializing exclusively in chocolate chip cookies. You have a small bakery and retail outlet down at the corner of Main and Elm in Small Town, USA. Because your family is not independently wealthy (not that it matters), you obtain your operating funds for purchase of cookie ingredients, store rent, and utility bills from your friendly banker—just down the street. Things have been going along quite well (you know, "good times"). With the national and local economies humming, an ample number of Small Town chocolate chip cookie lovers, and your friendly banker's $2,000-a-month line of credit, you've been happily baking and selling a thousand dozen (that's 12,000) cookies a month.

Of course, this is way too simple. So enter your cheerful economist to explain it all to you—not just any old economist but one like me who specializes in something called production economics. As we all know, economists love graphs. The relevant graph here is something appropriately called a production function—think of it as a flattop cookie mountain (see Figure 1). On the horizontal axis we have dollars' worth of cookie ingredients—a recipe combination of flour, salt, chocolate chips, and what ever else is in your secret delicious chocolate chip cookie recipe. On the vertical axis we have cookies produced (the number of cookies baked and sold) using various quantities of cookie ingredients, which, by the way, you purchase from your friendly, local cookie ingredient supplier. (Notice how everyone in Small Town is friendly; even the economist is cheerful!)

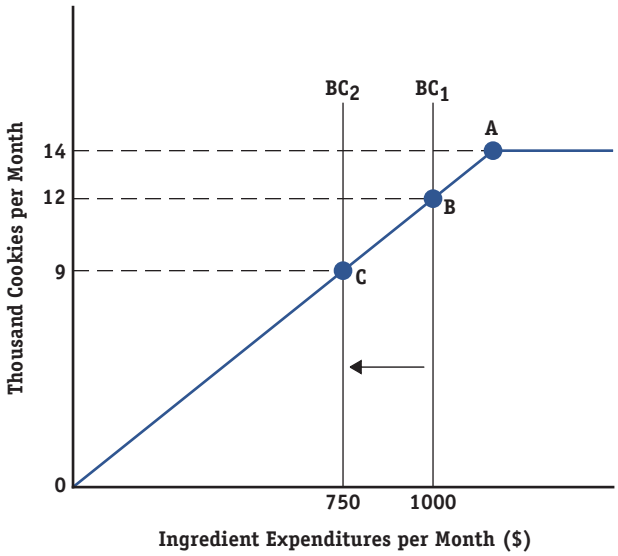


Fig. 1 Small Town Bakery's Cookie Production Function

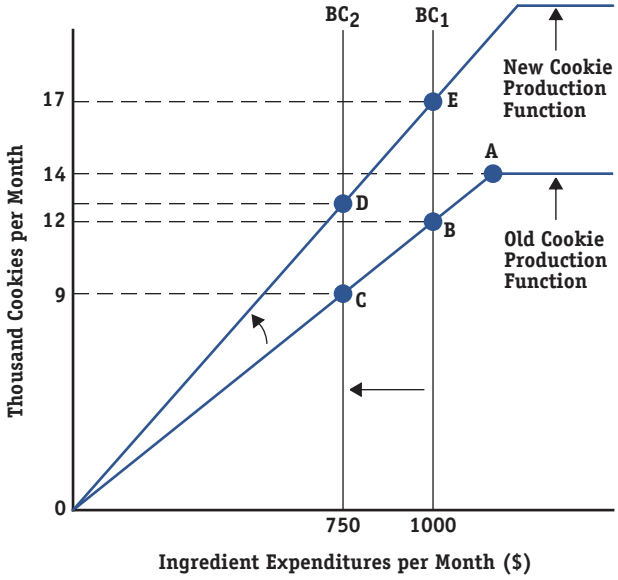


Fig. 2 Cookie Production Function Before and After New Technology

Figure 1 is indeed a nice (well-behaved) production function. We first notice that it takes more ingredients to make more cookies, i.e., as cookie ingredients increase, the number of cookies produced increases up to a maximum possible 14,000 cookies per month at point A. Why does our cookie mountain (cookie production function) max out (not that it matters) at 14,000 cookies per month? It's because of something I forgot to mention. Your bakery is quite small, scarcely 600 square feet with but one oven, and only you, the spouse, and one school-aged youngster for workers. No matter what you try, no matter how much cookie ingredient you fetch and attempt to push through the system, the maximum number of cookies you can produce in a month is 14,000. One month when you tried for more, your spouse got fuming mad and quit work early; Child Protective Services started paying your store a visit nearly every day; and the oven started acting up. The upshot was that even with more ingredients, the system could produce no more than 14,000 saleable cookies. About now you're beginning to wonder: So if you can produce and sell 14,000 cookies a month without excessive strain on your oven and spouse, and without having to endure the wrath of Child Protective Services, why are you only producing 12,000 cookies a month?

Enter your friendly banker. He likes you a lot and he realizes that you are Small Town's only second generation baker, but… Yes, but for whatever reason, he thinks you qualify for a maximum line of credit of $2,000 per month. (Remember that bankers, even friendly bankers, are a risk-averse and conservative lot.) Now $2,000 per month, after you've paid the rent, the utility bill, and minimum wage to the kid and spouse, leaves you only enough wiggle room to buy $1,000 worth of cookie ingredients, enough for 12,000 cookies. Thus, there is a vertical line in Figure 1 that cuts your production off at 12,000 cookies. As much as you might like, your banker-imposed *budget constraint* (BC_1), the quantity of funds available for purchase of cookie ingredients, limits you to X pounds of flour, Y pinches of salt, and Z handfuls of chocolate chips per month. Given your production function and your secret family recipe, X + Y + Z = 12,000 cookies and no more. Bummer, you are *constrained* to a maximum obtainable output of 12,000 at point B.

If that wasn't bad enough, welcome to the twenty-first century. We all know what happened more or less at the turn of the millennium. The economy went south on us—no longer "good times" with flush budgets and friendly bankers. Not only your portfolio and mine, but the banker's portfolio also went south and he got noticeably less friendly—not grumpy mind you, just less friendly. The banker generally worries, and he really worries about the implication of this economic downturn for the demand for chocolate chip cookies. Better safe than sorry is his motto. So, this month you discover that he's reduced your line of credit to $1,750. To make matters worse, you find that the lowest wage you can get away paying the spouse and kid is the minimum wage that you're presently paying. Your landlord informs you that she's standing firm on the monthly rent. The utility company cares not one whit about your plight. And to add insult to injury, the grocer informs you that the prices of flour, salt, and chocolate chips are unchanged.

So what happens to the vertical line in Figure 1? You guessed it: It shifts leftward from BC_1 to BC_2. Are you now able to purchase more, the same, or fewer ingredients than you did before? Are you now able to produce more, the same, or fewer cookies than last month? According to the popular adage: "You need to, you must, you will do more with less." Baloney! Any rational person, household, or business firm can do only one thing with less, and that is less—not more, not the same—only LESS!! Your operating budget *constrains* you to the purchase of $750' worth of cookie ingredients (remember, the $1,000 used for spouse and child wage payments,

the rent, and the utilities comes off the top of the $1,750), and $750 allows only the purchase of enough ingredients for 9,000 cookies (point C in Figure 1). In the real world of real business firms with real production functions and real constraints, not the least of which are budget constraints, "doing more with less" is clearly invalid on its face. Why the idea persists as such a popular admonition and rallying cry is a mystery to me.

Learning to Do More with Less—More Nonsense

Now hold on here Bruce, maybe you are jumping to too hasty a conclusion. Perhaps what people mean when they say "doing more with less" is not literally "doing more with less," but rather they think we should, indeed must, and will "*learn* to do more with less." Now there's a creative idea that even a production economist might find acceptable. Let's see how this works—on to Chapter 3 and Figure 2.

Figure 2 is similar to Figure 1 with one added feature. First notice that the "curve" labeled "old cookie production function" is identical with that in Figure 1. The curve labeled "new cookie production function" is similar to the "old" one except now for every unit of cookie ingredients, you are able to produce more cookies than you did before. You have discovered a "new and improved" production technology. Maybe it's a better oven, or a new and improved recipe, or the additional schooling/training of the kid—how do I know? You, after all, are the creative entrepreneur in this cookie business, not me. However, you did it, you *learned* to do more with less. With your new tighter budget constraint, you are now producing nearly 13,000 cookies (at point D) compared to the 12,000 that you were producing before the onset of "bad times" and your banker-imposed reduced line of credit. Heck of a deal—right? What a clever team, you and your family. You have "learned to do more with less"—good for you!

But hold on, maybe there is something not quite right with this picture/story. Suppose I make the following observation and ask you a nasty, bubble-bursting question: "I notice with the 'new cookie production function' in Figure 2, that given your old budget constraint (before your banker cut you back to $1,750 a month), you could have been producing 17,000 cookies per month (at point E) rather than 12,000 (at point B). Why, for goodness' sake, did you not take advantage of 'learning' (the adoption of the new and improved technology) before imposition of the tighter budget constraint? If point B was good, would not point E have been even better?" What is it that precluded or discouraged you from "*learning* to do more" with the "more" (BC_1) you had in 1999?

The Upshot

The idea that individuals, households, or business firms "can do more with less" is pure nonsense. The idea that we "can learn to do more with less" is not pure nonsense, but close to it. Sure, "we can learn to do more with less," but that clearly begs the question: Why should or does it take "less" to trigger creative juices and learning? Why not creativity, improved technology, and/or learning when budget constraints are unchanged or relaxed (increased)? Which brings us full circle back to Chapter 1: Why is it that so many believe a stick (a lower budget) will motivate improved outcomes, but a carrot (the possibility of greater output and profit absent a lower budget) will not? There can be only one answer, and that from one of the wisest men I've ever known: "Damned if I know, Son!"

Epilogue: So…What to Do?

The *Review* editor strongly suggested that I add an idea or two about what to do when confronted with the admonishment to "do more with less." At first I thought that was a silly idea: If something is invalid, then we should simply refrain or ignore—end of story. But upon second thought, perhaps he has a point. I do have a couple of ideas.

First, if you are at the top of the organizational chart of a business firm, a governmental agency, or a university, you should think very carefully about whether to invoke the "let's do more with less" admonishment. At a minimum, lower-level managers/administrators and other employees may wonder about your intelligence, your leadership skill, and/or your credibility. At worst, you will succeed in negatively affecting morale and worker productivity. Fully employed, talented, and productive lower-level managers and workers, when admonished to do what they clearly cannot do, will become increasingly stressed, exhibit reduced loyalty and organizational citizenship, and productivity and product quality will almost certainly suffer.

If you are a mid-level manager or worker and a superior makes a public pronouncement about getting on with "doing more with less," don't immediately panic or succumb to rage. Remember, those at the top of organizations always, when they speak, simultaneously address multiple audiences—especially when making public statements. (Also, remember that seasoned managers know that it is wise to assume that all their statements and conversations, including private conversations, will become public.) So, cut them a little slack. As noted earlier, most of us realize that we cannot literally do more with less. Yet we universally hold on to the

view that others can and should (do more with less). It may be that your superior officer, in fact, knows that you cannot do more with less, but he/she nevertheless believes (perhaps correctly) that it is what must be said to win the continued support of stockholders, customers, taxpayers, or other "outside" stakeholders.

Lastly, and most importantly, what we can and should do when confronted with a deteriorating budget or staffing situation is to prioritize and reduce or eliminate low priority activities (downsize or downscope) in order to maintain effort levels associated with higher priority needs. We *can* and *should* do less of the presumably valuable but nevertheless lower priority activity. And one of the things that a wise manager (high-, mid-, or low-level) will do is to enlist the advice and counsel of his/her juniors all the way down to the worker level in identifying and making those difficult choices. The further "down the line" those choices can be identified and made, the more likely the choices will be good ones, and the more likely the desired outcome will be achieved. But make no mistake about it, reducing or eliminating a lower positive-valued activity in order to maintain the quantity and quality of other higher-valued activities is to do *less—not the same, and certainly not more!* AR

Acknowledgments. *The author appreciates several helpful comments and suggestions of Harry Ayer, the* Review *editor, and Jennifer Beattie, Human Resource Information Systems Manager, Bear Creek Corporation, Medford, Oregon.*

Bruce Beattie *has broad research and outreach interests in agricultural economics, including production economics, the importance of agriculture in regional and national economies, and the role of markets in fostering economic well being. He is a past president of the Western Agricultural Economics Association, the American Agricultural Economics Association, and the National Association of Agricultural Economics Administrators. Bruce enjoys teaching freshman-level principles of economics and production economics theory for beginning graduate students.*

Endangered Species Protection

Takings, Preemption, and the Case of the Pygmy Owl

Robert Innes
innes@ag.arizona.edu
Professor
Agricultural and Resource Economics
University of Arizona

Daniel Osgood
deo@ag.arizona.edu
Assistant Professor and Extension Specialist
Agricultural and Resource Economics
University of Arizona

As of October 2001, Arizona had 59 plant and animal species listed as threatened or endangered under the Federal Endangered Species Act (ESA), including the cactus ferruginous pygmy owl that has generated controversy in Southern Arizona. The ESA protects endangered species on both public and private lands. Section 7 of the ESA provides strict and overarching limits on federal agency actions, proscribing any action that may "jeopardize" an endangered or threatened species or adversely change its habitat. In principle, the designation of "critical habitat" for an endangered species also speaks only to federal actions; any federal action that modifies such habitat requires the approval of the U.S. Fish and Wildlife Serve (the federal agency charged with enforcing the ESA).

Perhaps the most controversial feature of the ESA is Section 9, which prohibits citizens from "taking" any threatened or endangered species on their private property. The Fish and Wildlife Service has interpreted "taking" to mean any action which injures or kills an endangered creature or significantly modifies its habitat (an interpretation recently upheld by the Supreme Court). The scope of this protection is potentially very wide indeed. For example, some estimate that as much as 75 percent of the prospective habitat for the endangered red cockaded woodpecker is in private pine forests in the Southeastern United States. Habitat protections for the Northern Spotted Owl may potentially restrict logging on hundreds of thousands of private forest acres in the Pacific Northwest. Private California farmland is habitat to the endangered Tipton

kangaroo rat, the San Joaquin kit fox, and the blunt-nosed leopard lizard. Indeed, more than half of the listed endangered species have at least 80 percent of their habitat on private land. In Arizona, approximately 130,000 acres of proposed critical habitat for the pygmy owl are privately owned.

Restrictions imposed upon private landowners by ESA protections can be very costly. However, the ESA does not require that landowners be compensated for any losses suffered as a result of ESA restrictions. Although the U.S. Constitution proscribes any government "taking" of private property without just compensation, the absence of compensation for species protection is generally considered constitutional. The economic wisdom of this practice is less clear, potentially providing incentives for landowners to use their property in ways that are not efficient—that is, not compatible with society's overall economic interests. We now turn to two of these possible incentive costs of current practice, before describing some evidence on these effects in the pygmy owl case.

Environmental Protection Incentives

While landowners make decisions that affect the private use value of their land, their decisions can also inhibit or promote conservation. For example, if landowners are not compensated when their land is taken for endangered species preservation, a number of economists have argued that they do not have an incentive to protect the species and, indeed, will take actions that reduce the likelihood that their land will be valuable as habitat. The case of Benjamin Cone is illustrative. To protect habitat of the red cockaded woodpecker, a bird that makes a home in old growth pine forests, Cone was denied logging rights on 1,560 acres of his old growth trees in Greensboro, North Carolina, at a cost to him of approximately $2 million. After faced with the logging restriction, Cone was quoted as saying: "I cannot afford to let those woodpeckers take over the rest of the property. I'm going to start massive clear-cutting. I'm going to a 40-year rotation instead of a 75- to 80-year rotation." Lambert and Smith cite a related phenomenon in the Pacific Northwest, where officials of the U.S. Fish and Wildlife Service have observed accelerated harvesting of old growth Douglas fir plantations that are potential habitat for the protected Northern spotted owl.

When landowner choices affect the value of their land in "public uses," such as endangered species habitat, compensation is generally needed to elicit efficient landowner behavior. If compensated for an ESA "taking," a landowner has an incentive to protect habitat, rather than destroy it. Unfortunately, such compensation leads to what economists call "deadweight costs" of government taxes; these deadweight costs are not small, estimated to be on the order of ten to thirty cents on the dollar, including direct administrative expenses from tax collection, labor/leisure distortions from income taxation, and investment incentive costs of profit taxes. To limit these costs, the government should strive to provide appropriate land-use incentives with minimum possible compensation. One low cost approach would compensate a landowner only when he efficiently protects habitat. Under this regime, if private land is "taken" for habitat, a landowner is paid just enough to compensate him for the costs of his habitat conservation efforts; because no compensation is afforded when efficient conservation is not performed, landowners prefer to act as good environmental stewards of their property.

Early Development Incentives

When the government designates habitat for an endangered species, it generally does not order that existing houses be torn down; instead, it restricts development on land that has been left in its natural state. The reason is simple: it is much less expensive to "take" undeveloped land than it is to take developed land. However, if owners of vacant land are not compensated when their land is taken—the ESA policy—then landowners have a powerful incentive to develop their property prematurely in order to preempt subsequent regulation. Some "takings compensation" is needed to avoid this incentive for this type of preemptive development, or "preemption."

The Pygmy Owl in Southern Arizona

Habitat conservation and preemption are important phenomena in the case of Southern Arizona's pygmy owl. While relatively abundant in Mexico, the pygmy owl *(Glaucidium bralisianum catorum)* was listed as an endangered species under the ESA in March, 1997; by law, the listing decision was based on purely scientific (and not economic) criteria and considered regional (not cross-border) scarcity. Since that time, debate has centered on the designation of "critical habitat" for the pygmy owl, a designation that requires consideration of economic costs and benefits, and is intended to secure the recovery of the endangered owl. Despite some claims to the contrary, it appears that critical habitat designation for private land can be costly for a number of reasons. Building permission and land clearing on such property may

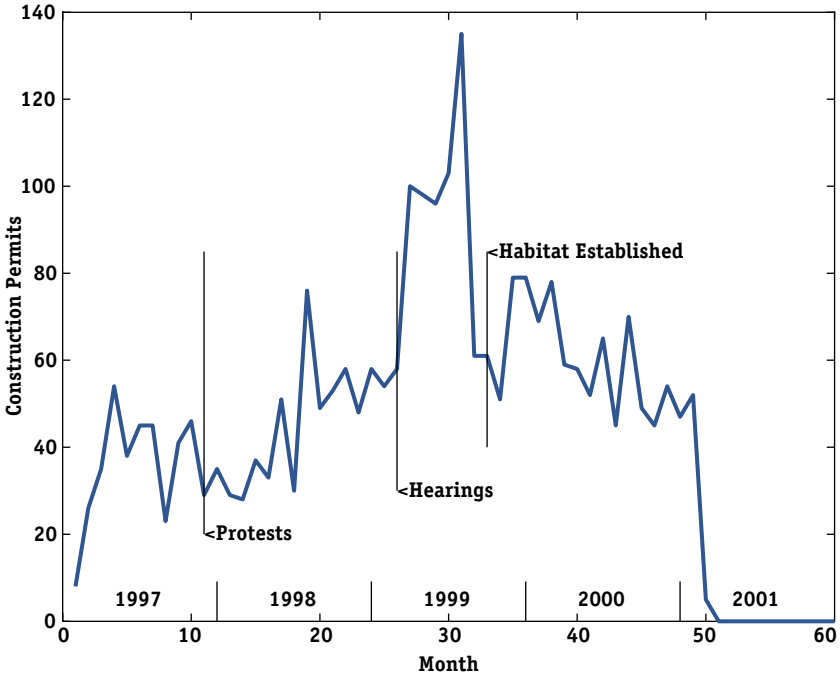


Fig. 1 Monthly Construction Permits in Critical Habitats

require not only local permitting, but permission from the U.S. Fish and Wildlife Service (FWS) for a so-called "incidental take." In March 2000, the FWS announced "toughened owl survey guidelines" advising developers or individuals who clear land within the pygmy owl habitat to conduct up to six surveys in a two-year period. Those who clear land in pygmy owl habitat without authorization could be fined or imprisoned. Parallel local regulations also impose costs on private developers of "critical habitat"; for example, Pima County has recently required private developers to perform a year of owl surveys. In addition, the county is developing the multi-species Sonoran Desert Conservation plan, which could potentially impose much more severe restrictions on construction. A critical habitat designation can directly limit public construction as well, including roads, schools, and other infrastructure investments.

After public hearings, the FWS designated critical habitat boundaries for the pygmy owl in August 1999, including approximately 730,000 acres of Southern Arizona property. In September 2001, federal courts threw out the original designation for failing to properly weigh economic costs and benefits as required by law. In November 2002, a new critical habitat was proposed, containing 1.2 million acres of Southern Arizona land. The Bush administration is seeking delays in the development and implementation of a final plan, and has also consistently designated smaller final "critical habitat" areas than have been originally proposed—50 percent smaller on average. Despite regulatory efforts to protect the pygmy owl, the estimated number of adult owls in Arizona has declined from 41 in 1999 to only 18 in 2002. An August 19, 2003 ruling of the Ninth U.S. Circuit Court of Appeals cast further doubt on the regulatory status of the pygmy owl, questioning its entitlement to endangered species protection altogether.

Recent empirical work has studied the effect of potential "critical habitat" designation on building activity. Preliminary results support the preemption hypothesis. These results are illustrated in Figure 1, which shows monthly applications for Pima County building permits in the 1999-designated pygmy owl "critical habitat." The figure illustrates a sharp increase in building permit applications prior to the designation of "critical habitat" in August 1999, suggesting that landowners rationally sought to develop their property before their land could be regulated. Work is being performed to determine if the effect is statistically significant.

Costs of preemption and habitat destruction argue for incentive-based approaches to ESA regulation that include some implicit compensation for landowner donations to species habitat. Such compensation may take the form of tax deductions and land swaps, as well as cash transfers. While there are compelling economic reasons to keep these compensations as small as possible, there are equally compelling reasons to make these compensations sufficient to make it worthwhile for landowners to protect habitat on their property. AR

For More Information

Innes, R. "The Economics of Takings and Compensation When Land and Its Public Use Value Are in Private Hands," *Land Economics* 78(2000):195–212.

Innes, R., S. Polasky, and J. Tschirhart. "Takings, Compensation and Endangered Species Protection on Private Lands," *Journal of Economics Perspectives* 12(1998):35–52.

Osgood, D., J. List, and M. Margolis. "Closing the Barn Door: Construction and Endangered Species Restrictions," Paper presented at the Western Agricultural Economics Association Meetings, Long Beach, California. July 2002.

Shogren, J., and J. Tschirhart (eds). *Social Order and Endangered Species Preservation*. Cambridge: Cambridge University Press, 1999.

Robert Innes' *research focuses on agricultural policy, environmental economics, law and economics, and industrial organization.*

Daniel Osgood's *work addresses the spatial impacts of information in economic decision making.*

Managing to Avoid Crisis

A Look at Water Management Efforts in Rural Arizona

Sharon B. Megdal
smegdal@ag.Arizona.edu
Associate Director, Water Resources Research Center
Professor and Specialist, Agricultural and Resource Economics
University of Arizona

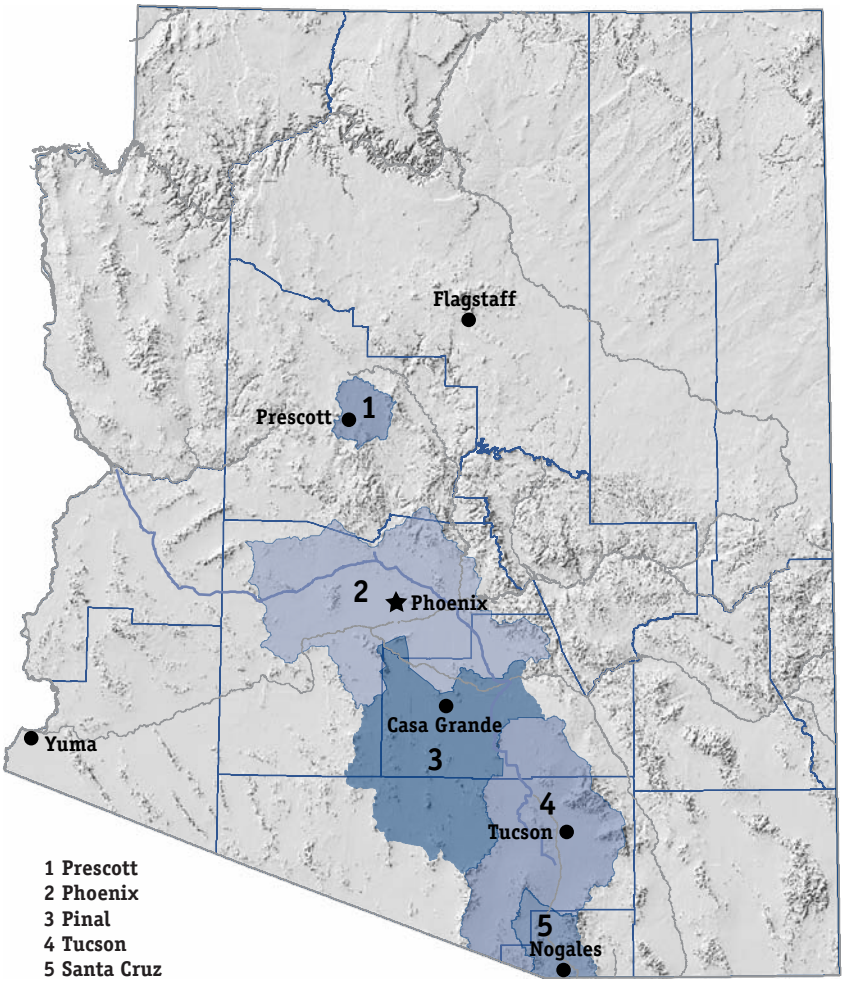
Jacqueline Moxley
jmoxley@ag.Arizona.edu
Research Specialist
Water Resources Research Center
University of Arizona

Water is a scarce commodity in Arizona. While market forces tend to determine the allocation of most goods and services, a complicated system of law and institutions superimposed on varying land and water forms and patterns of development makes the allocation of water resources extraordinarily complex. Add to that Arizona's rapid population growth rates, the potential for conflict over water resources is great.

The quote attributed to Mark Twain, "Whiskey's for drinking, water's for fighting about," points to a long history of water resource conflicts. No stranger to water conflicts, Arizona has a good record of resolving them. The 1980 Groundwater Management Act is hailed as an innovative, successful framework for managing groundwater in parts of Arizona designated Active Management Areas. Figure 1 shows the location of the five AMAs. Enactment of rules governing new municipal uses of groundwater and increasingly stringent water management plans have assisted the AMAs in moving toward their state-mandated groundwater management goals. Since the passage of the Act, the Central Arizona Project has been completed. Its delivery and storage capabilities have provided dry and thirsty Central Arizona communities with surface water needed to sustain and grow their economies.

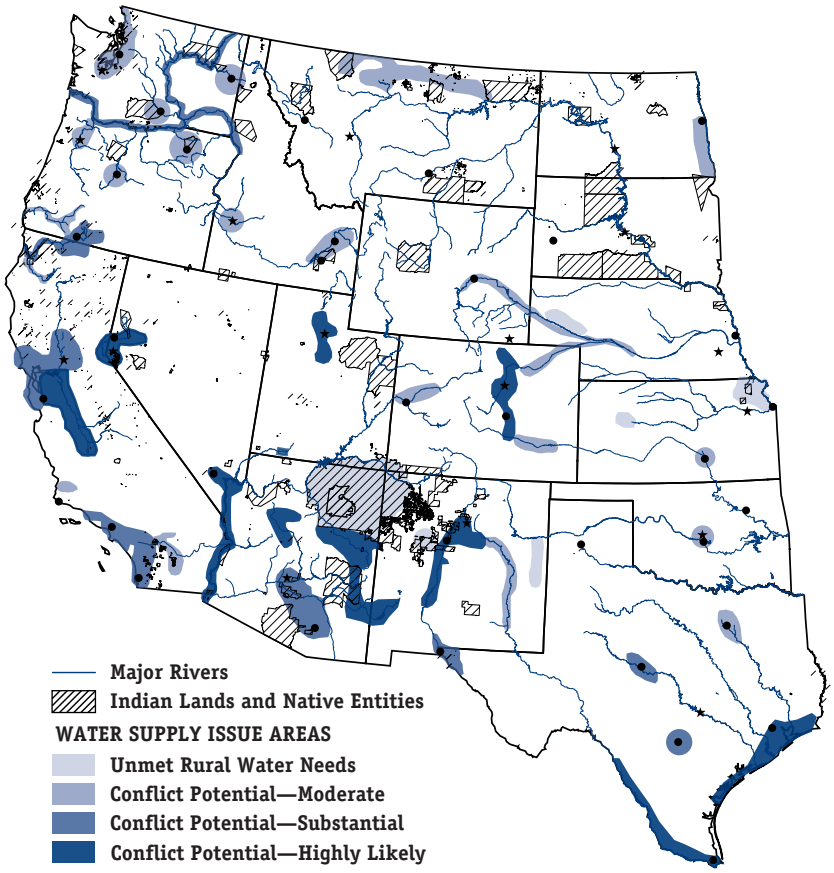
Despite our great strides, the recently released United States Department of Interior report, *Water 2025: Preventing Crises and Conflict in the West,* confirms what we already knew here in Arizona: "...explosive population growth..., the emerging need for water for environmental and recreational uses, and the national importance of the domestic production of food and fiber from western farms and ranches is driving major conflicts between these competing uses of water." Figure 2 shows varying levels of future water supply crises in the West. Arizona has more than its share of shaded area, including sizable areas outside AMA boundaries.

Arizona is not waiting for conflict to become crisis. The Groundwater Management Act continues to provide the framework for managing water resources in the AMAs. But what about other areas of the state? Recognizing the need for rural areas of the state to develop and implement long-term water plans, the legislature authorized the Arizona Rural Watershed Initiative. Funded for the first time in state fiscal year 2000, its purpose is to provide planning and other technical assistance to rural areas with expanding populations and limited groundwater resources. Watershed groups are actively involved in gathering information and considering their water management options. The remainder of this article provides an overview of the process and progress of these watershed efforts. Much of the information was gleaned from an annual Arizona Water Resources Research Center conference ("Local Approaches to Resolving Water Resource Issues") held in Prescott, Arizona in May of 2003.



Source: Arizona Department of Water Resources

Fig. 1 Active Management Areas



Source: U.S. Department of Interior

Fig. 2 Future Water Supply Crises in the West

Process Is Important

Resolving water management issues is a long and costly process. A large number of persons, groups, government agencies, and other entities concerned with water are typically involved. It is important to bring all stakeholders to the table, even those who may be disagreeable. Failure to be inclusive exposes the process to the risk that an overlooked or omitted party could in the end interfere with carrying out the agreed-upon plan. People need to listen to each other. Spending time and money to educate individuals from the beginning of the process is worthwhile, so that everyone has the same base information for informed dialogue.

The parties must develop a good working relationship if agreement to implement a plan is to be achieved. Everyone must know and understand the viewpoints of the participants. An independent mediator who facilitates negotiations, someone to listen and direct constructive discussion, can be helpful. While it is important that good, objective technical assistance be provided, the mediator may play the most critical role in arriving at a solution that the parties can agree to follow.

It is important to identify common goals and formulate the appropriate research questions to be investigated. Collaborative regional efforts commonly lack funds for research necessary to fill information gaps. When seeking outside funding for research needs, success is more likely if the region speaks with a single voice rather than with competing ones. Federal agencies encourage and respond to locally developed approaches to investigating water issues. By providing funds and technical assistance, federal or state agencies can become key facilitators. The local or regional water groups, however, are the ultimate implementers.

Research takes time; data collection and development of groundwater models may take several years. However, "paralysis of analysis" is a risk. While it is usually desirable to base actions on more information rather than less, groups sometimes cannot wait for all the information before moving ahead, at least on some programs. It is possible to consider a variety of alternative strategies, some shorter term and some longer term. For example, some low-risk projects can be implemented while awaiting study results. Solving water issues is truly work in progress and requires creativity. There is no silver bullet or one-size-fits-all solution.

Throughout the process, water managers and others should work to keep the public and decision makers well informed. The process must be open, and any interaction with the public has to be meaningful and inclusive for solutions to be acceptable.

Once solutions are found, and an approach is negotiated, assurances for all parties have to be made and have to be enforceable for implementation to be successful. The work of the group is not over at that point; the commitment to the program or plan can extend far into the future.

A Selective Look at the Watershed Efforts

Watershed groups throughout the state, as shown in Figure 3, are actively involved in gathering information and considering their water management options. A look at the activities of some groups provides a glimpse of the variety and complexity of regional water challenges.

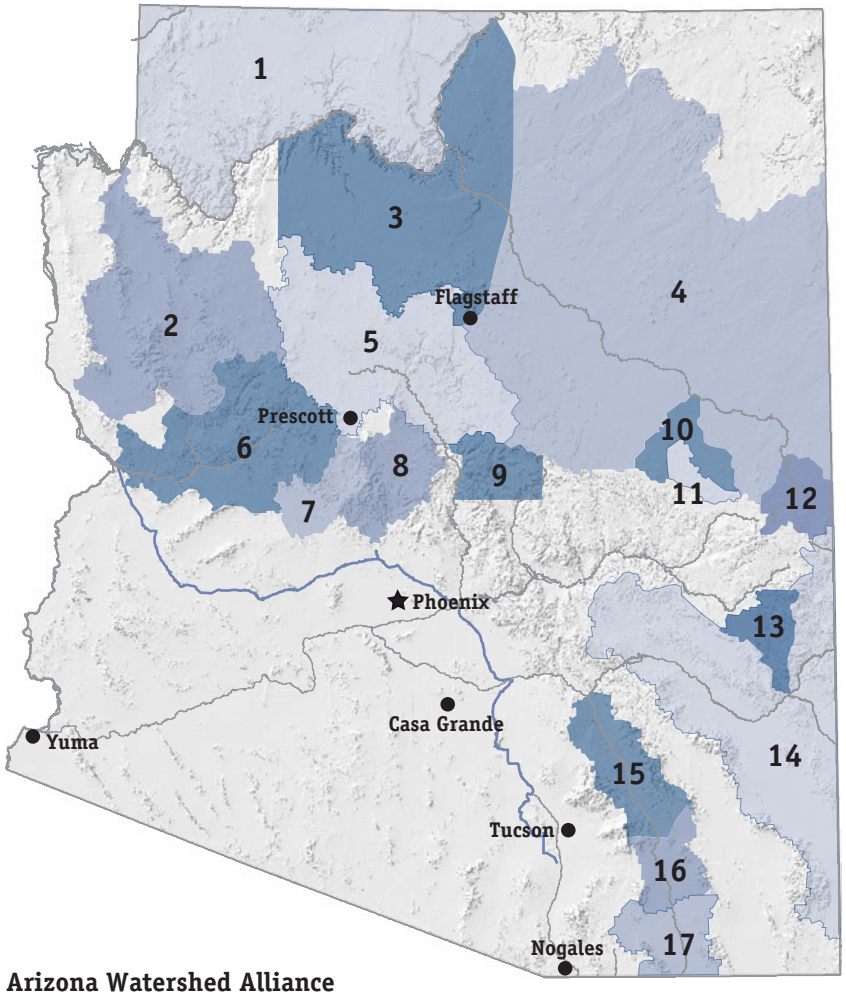
The Verde watershed, which includes rapidly growing parts of Yavapai County, is a hotbed of activity. The beauty of the region coupled with rapid growth rightly has people concerned about balancing the needs of nature with the needs of people. There is active participation of many diverse interests, and progress is being made in acquiring and disseminating information. The recently formed North Central Regional Watershed Consortium, in an effort to coordinate the many Verde watershed citizens groups, will share information and provide a stronger voice to further common goals.

Concern is significant about the activity of new and existing exempt wells in the Prescott AMA portion of the watershed and the unregulated drilling in the non-AMA portions of it. The situation is complicated because of the importance of surface water and the rights to that surface water. Prescott Valley, for example, which is located in the AMA, has faced incredible pressure due to the rapid growth rate and shortage of water supplies. In the last ten years residents have moved from septic systems to a water treatment facility and from private ownership of their water supply to municipal ownership. They have introduced conservation measures to reduce water use. Increases in impact fees, charges for water hookups for new single family homes, and water rates and wastewater reuse have helped to mitigate some of the water demand pressures, but Prescott Valley, as well as others in the region, recognizes the need to identify additional water sources.

The Gila River watershed, which includes the Safford area, supports cattle ranching, agricultural production, and mining. The watershed group is working to resolve pressing issues of water quality such as salinity, turbidity, non-point source pollution, and flood mitigation. There are concerns not only for endangered species, but reintroduced species and invasive plant species, and the associated costs of dealing with those concerns. Progress has been made to smooth old conflicts between agricultural and environmental groups, but lack of technical information and the funds needed to do the research are restricting the ability to resolve issues.

Flagstaff, part of the Coconino Plateau region, has successfully used a variety of conservation measures such that per capita water use has decreased one percent per year since 1990. Changes to the water rate structure have encouraged reductions in water use. A water conservation ordinance, effective May 15, 2003, for the first time imposes conservation requirements 365 days of the year. It is enforced by bike patrol and has penalties. The ordinance has been well supported by the public. Rebates and incentives for low flow toilets, conversions to gray water, turf reduction, and rain barrels have also been well received. A dual distribution system, online since 1992 and funded through a bond program, has enabled delivery of reclaimed water for outdoor irrigation. This resource is thought to be one of the most significant groundwater conservation tools the city has. Although Flagstaff has made strides in reducing groundwater use, the city and others in the region have yet to agree upon plans for augmenting water supplies.

The activities of Fort Huachuca and concerns about San Pedro River flows have been central to the endeavors of the Upper San Pedro Partnership. Formed in 1998, the partnership has brought twenty government agencies and private organizations together to develop a working water conservation plan for the Sierra Vista sub-watershed and the San Pedro River. This area is not in an AMA and there is no particular desire for that designation to occur. Reducing consumption, reclaiming and reusing water, and augmenting existing water resources are the three distinct water management strategies for this group. Watershed improvement projects to improve and restore grasslands and riparian areas and partnership-sponsored studies to provide research are also part of the mix. These measures are reviewed on an annual basis to assess the benefit to water resources management. Strong federal interest has assisted this group in investigating and pursuing this vast array of alternative solutions.



Arizona Watershed Alliance

1 Arizona Strip
2 Northwest Arizona Watershed Council
3 Coconino Plateau Regional Water Study
4 Little Colorado Multi-Objective Management
5 Upper Verde and Middle Verde Studies
6 Upper Bill Williams
7 Upper Hassayampa
8 Upper Agua Fría
9 Northern Gila County Water Plan Alliance
10 Silver Creek
11 Show Low Creek
12 Upper Little Colorado River Partnership
13 Eagle Creek
14 Upper Gila
15 Lower San Pedro
16 Middle San Pedro
17 Upper San Pedro Partnership

Source: Arizona Department of Water Resources

Fig. 3 Rural Watershed Groups

Common to these and other regional efforts is a desire for solutions to be developed at the local and regional level, rather than at a centralized (state) level. Nevertheless, there is a role for state and/or federal legislation, particularly when it comes to resolving Indian water claims and developing workable financing mechanisms. Funding the identified and agreed-upon projects is clearly a challenge for most regions of the state.

Concluding Remarks

In Arizona, water managers are faced with the difficult task of balancing limited water supplies with the competing demands of population growth, economic development, and environmental needs. There may be complex layers of regulation, and financial resources are limited. Multi-dimensional solutions are required.

Watershed groups and those working collaboratively in other parts of the state are making progress in identifying and implementing solutions to their water problems. Their efforts to resolve water conflicts *before* they reach crisis stage deserve the involvement and support of all concerned about sustaining Arizona's economy and quality of life. AR

Acknowledgment. *The authors thank Peter Wierenga for helpful comments.*

Sharon B. Megdal's *work focuses on Arizona water resources policy and management. Active areas of research include the role of the private sector in water delivery and long term water storage, regional approaches to water management, and how the desert's landscape has been affected by water management. She writes a public policy column for the Arizona Water Resource, the bi-monthly WRRC newsletter, and regularly makes presentations on water matters to diverse audiences.*

Jacqueline Moxley *is both a researcher and program coordinator at the WRRC. Research and analysis of data related to water issues in the state is the focus of her efforts. Current areas of interest include the role of the private sector in water delivery, effluent reuse, and home water treatment.*

Dust Mitigation Via Reduced Tillage

The Economic Dimension

Ana Kennedy
aken02@hotmail.com
Graduate Student
Agricultural and Resource Economics
University of Arizona

Paul Wilson
pwilson@ag.arizona.edu
Professor
Agricultural and Resource Economics
University of Arizona

Airborne dust can aggravate cardio-pulmonary conditions leading to illness, higher medical expenses, and an increased number of sick leave days. The population in the western region of the United States is more prone to dust events due to climatic and physical environment: low rainfall, drought, high wind velocity, fine soils, and sparse vegetation. Dust storms have occurred naturally in desert areas for millennia. In recent decades, human activity has compounded the natural dust problem with agricultural production practices, an increase in construction activity on the urban periphery, and the ever-closer proximity of agricultural production to urban areas.

A federal-state partnership implements the Clean Air Act for improving national air quality. The Environmental Protection Agency (EPA) is responsible for developing national ambient air quality standards (NAAQS) and the Clean Air Act regulatory guidelines that the states use to develop state implementation plans (SIPs). A SIP is a package of strategies and control measures to prevent air quality deterioration or reduce criteria pollutants (i.e., particulate matter, carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, and lead) that exceed NAAQS. State environmental agencies are the implementation leaders of the Clean Air Act because air quality problems are unique to each area of the country.

Wind blown dust is the primary component of one type of particulate matter, PM-10, consisting of "coarse" particulates 10 micrometers in diameter—10,000 could fit in the period at the end of this sentence. The EPA is responsible for establishing the primary (protecting public health) and secondary (protecting the environment and public welfare) standard for each NAAQS. For PM-10, the primary standard consists of an annual standard (50 micrograms per cubic meter [ug/m3]) and a 24-hour standard (150 ug/m3).

What Is the Issue?

In November 1990, the EPA designated 2,880 square miles of Maricopa County that violated the 24-hour and annual standards of the Clean Air Act as a "moderate" PM-10 nonattainment area. The required development of Maricopa County's PM-10 SIP then took 12 years. During that period, the EPA rejected two SIPs. A third SIP was accepted and approved in 1995, but this federal action led to a lawsuit by the Arizona Center for Law in the Public Interest claiming the SIP failed to mitigate PM-10 problems. In 1996 the EPA reclassified Maricopa County as a "serious" PM-10 nonattainment area and began the development of a Federal Implementation Plan (FIP).

Agriculture became a major issue in the mid-1990s as a result of a microscale study conducted by the Arizona Department of Environmental Quality. The controversial results from four of the five PM-10 monitoring sites produced 24-hour violations. Agricultural fields were predominant in two of these four sites. The Arizona Department of Environmental Quality was not able to develop control methods that would meet the primary standard for the agricultural sources of dust, so the EPA decided to use a best management practices (BMP) approach in the FIP with the active participation of key stakeholders within and outside the agricultural community. Then in 1999, the EPA and the State of Arizona reached an agreement that approved the use of acceptable BMPs in agriculture as a substitute for the EPA's FIP. In 2000, regulations for the BMP-based agricultural PM-10 general permit were promulgated—in doing so Arizona became the first state in the nation to regulate agricultural practices aimed at limiting dust with the approval of the EPA.

The Governor of Arizona's Agricultural BMP Committee and its ad-hoc technical advisory group developed a comprehensive list of 65 BMPs based on (1) academic literature and technical documents on wind erosion and dust control, (2) their suitability to Arizona soils, (3) their impact on soil erosion, (4) cost, and (5) cost effectiveness. The Committee reduced this list to 30 BMPs and organized them under three categories: tillage and harvest, cropland, and noncropland. By December 31, 2001, farmers in the PM-10 nonattainment area were required to adopt at least one BMP in each category and keep a written record of the actions taken. Enforcement is complaint driven, due to the lack of resources to verify compliance, and is the responsibility of Arizona Department of Environmental Quality.

Economic Analysis

Our economic analysis of potential reduced tillage systems to mitigate dust problems involved two types of evaluation: (1) a partial budget analysis of the profitability of the three reduced tillage systems relative to conventional tillage, and (2) a survey-based study of the willingness-to-adopt reduced tillage systems in central Arizona agriculture. The Sundance, Paratill, and Pegasus systems (henceforth called single pass multiple operation equipment [SPMOE]) either replace the entire conventional tillage system (i.e., cut stalks, disk residue, rip, second disking, and listing) or reduce the number of operations through the use of this alternative equipment.

Partial budgets were constructed to evaluate the change in net returns of switching from the conventional system to one of the three SPMOE systems. Partial budgeting is an analytical tool that looks at an ongoing business and compares the costs and returns of alternative plans or proposed changes that do not impact the total business operation. Only those costs and returns associated with the proposed change were included in the partial budget model.

Due to growers' concern regarding yield reductions with SPMOE, a sensitivity analysis was prepared under the condition of small reductions in yield. An additional sensitivity analysis was conducted to determine the impact of a state tax credit on the economics of an SPMOE investment. Arizona tax law (ARS §§ 43-1081 and 43-1170) provides a tax credit for equipment used to control or prevent pollution. The amount of the tax credit is 10% of the purchase price and is applied to an individual's or business' state income tax return.

To evaluate the willingness-to-adopt reduced tillage systems, a mailing list of all cotton growers in Maricopa and Pinal Counties was assembled from pesticide permit records from the Arizona Department of Agriculture and cross-referenced with extension mailing lists utilized by the cotton specialists in each county. Growers in Pinal County were included in the surveyed group because a part of the Maricopa nonattainment area extends into Pinal County and growers in this largely agricultural county south of Phoenix would act as a control group for the adoption decisions. Two hundred thirty-seven growers were surveyed: 119 in Maricopa and 118 in Pinal.

A mail questionnaire was developed to gather information on current farming operations, perceptions of dust as an environmental problem, reduced current tillage operations (RCTO), estimated benefits of RCTO and SPMOE, willingness to adopt SPMOE, and basic socioeconomic information including the distance from the center of the farm to the edge of the nearest residential housing area. The design of the willingness-to-adopt questions followed the general recommendations for contingent valuation studies. The questionnaire was reviewed several

times by the Pinal County cotton specialist and pretested with four cotton growers, two from each county.

One hundred twenty-eight respondents (54%) returned their "completed" questionnaires. Thirty-three growers responded that they were no longer farming cotton. Twenty additional responses were eliminated from the data set due to incomplete or inconsistent responses to specific questions.

What Did the Study Find?

The results of the partial budget analysis indicate that replacing the conventional tillage system with any of the three SPMOE systems yields an increase in net income. The Pegasus system had the highest profitability under our assumptions, followed by the Sundance and the Paratill systems. Replacing the conventional system with the Pegasus system produced an additional $25.91 per acre while the Sundance and Paratill systems increased income by $16.76 and $16.06 per acre, respectively. The return on investment on all three systems exceeded 70%. The State tax credit slightly increased each one of these performance measures.

The perceived reduction in cotton yields by growers may explain why SPMOE has not been adopted widely. However, there is no conclusive evidence in the agronomic literature that SPMOE has an adverse impact on cotton yields. The sensitivity analysis of a 5% reduction in cotton yield produced a significant change in net income to equally large negative values (losses) for all three systems. This risk-return tradeoff with SPMOE, and the growers' risk perceptions, may determine their willingness or unwillingness to adopt reduced tillage systems.

Sixty-two percent of the cotton growers responding to the survey acknowledged that dust generated by tillage operations can create an environmental nuisance. A majority of these respondents, however, believed this nuisance was not a severe problem. Only seven percent of the growers labeled the problem as very severe or severe. Thirty-six percent of all respondents classified their tillage operations as not creating a dust problem while three percent did not know if tillage activities created an environmental nuisance or not.

Among the adopters of some form of reduced tillage, 2 growers reported adopting SPMOE only, 22 adopted RCTO only, and 28 reported adopting both SPMOE and RCTO. Twenty-three respondents had not adopted either RCTO or SPMOE. RCTO adopters reported eliminating some disking, ripping, and listing operations. One or more disking operations were eliminated by 84 percent of the RCTO adopters and 52 percent reported eliminating ripping their fields. Thirty-two percent of the RCTO adopters eliminated one listing operation. Smaller farming operations and older operators tended to rely heavily on RCTO alone to compete in the current economic and regulatory environment. Only education differentiates the adopter and nonadopter groups, with adopters having a statistically significant higher level of postsecondary education. The two reasons most commonly chosen for both SPMOE and RCTO adopters were "to reduce costs" and "to reduce cost and dust." The two sole SPMOE adopters indicated that reducing costs was their only reason for adopting these tillage systems. None of the survey respondents chose "to reduce dust" as a reason for adopting reduced tillage systems.

The survey results show that RCTO have been adopted widely by cotton growers to reduce costs, sometimes in combination with SPMOE. Reported net benefits range from $15 to $55 and $10 to $100 per acre for RCTO and SPMOE respectively. Any dust reduction benefits emerging from fewer tillage operations become an added bonus to the grower and society. However, SPMOE alone does not represent a panacea to the agricultural dust problems in the Phoenix nonattainment area. At estimated long-term net benefits of $7 to $17 per acre, our analysis indicates that SPMOE alone may be adopted on less than 20 percent of the non-SPMOE cotton acreage remaining in Maricopa and Pinal counties. However, a combination of RCTO and SPMOE does have the potential to significantly reduce tillage costs—and reduce dust emissions—on a significant percentage of acreage in both counties. AR

Ana Kennedy *is interested in the political and regulatory issues facing farmers and ranchers in Arizona.*

Paul Wilson's *teaching and research programs center on the economics of modern commercial agriculture and the agricultural sector's interface with environmental and natural resource concerns.*

Arizona's Agricultural Situation

Satheesh Aradhyula
satheesh@ag.arizona.edu
Associate Professor
Agricultural and Resource Economics
University of Arizona

Agriculture featured very prominently in the recently concluded World Trade Organization (WTO) talks in Cancún, Mexico. New multilateral trade negotiations under the WTO were initiated for agriculture in 2000 and the talks in Cancún represent a midpoint in the trade round. Although the Cancún round of talks failed to produce an agreement, participating countries agreed to reconvene in Geneva, Switzerland by December 15 for further negotiations. Of particular interest for Arizona farmers are the cotton trade and price policies. International trade is important for cotton since 30 percent of the world's consumption of cotton fiber crosses international borders before final consumption. Cotton exports are particularly important for the U.S. cotton industry, with about 40 percent of the U.S. cotton harvest exported during the 1990s. Although U.S. cotton consumption is expected to shrink in 2003–2004, U.S. cotton exports are expected to reach a record 12 million bales as world cotton consumption continues to grow.

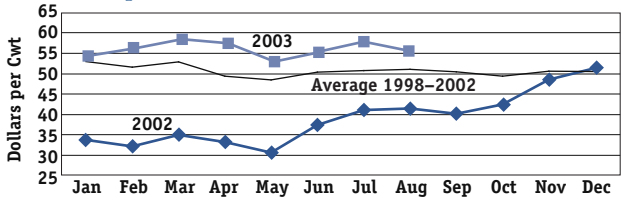
The USDA forecasts 2003 U.S. cotton production at 16.9 million bales, about 2 percent below last year's production. Arizona farmers are expected to harvest 211,900 acres of cotton in 2003, about 9,300 acres fewer than in 2002. With an anticipated drop of 66 pounds in upland cotton yields, Arizona farmers are expected to harvest only 579,500 bales of cotton, 50,800 fewer than 2002. After a steady increase in the later part of 2002, Arizona cotton prices have been fairly stable in 2003.

USDA expects Arizona farmers to harvest 245,000 acres of alfalfa hay in 2003, producing 1.96 million tons of hay. This represents a 5.3 percent increase in area harvested and 6.3 percent increase in production over 2002. Arizona alfalfa hay prices during 2003 have stayed close to historical 1998–2002 average prices but about $6 to $7 per ton lower than 2002 prices.

On August 8, USDA announced conditions for resuming imports of certain beef products from Canada while leaving in place the ban on live animal imports. Imports of ruminant meat products and live ruminants from Canada have been banned since May 2003 when a cow in Canada was found to have bovine spongiform encephalopathy. Rapidly deteriorating grazing conditions in the U.S. from the Western States to the Great Plains add further uncertainty to the beef supplies. Cattle inventories continue to decline in 2003 as drought and increasing market uncertainties make producers reluctant to expand. As of August 1, 2003, the national inventory of cattle on feed for slaughter had decreased 0.5 million head, a drop of 5 percent from the previous year. Cattle on feed inventory in Arizona followed the national trend with a 19,000-head drop. On August 1, 2003, Arizona had 266,000 head of cattle on feed, down 6.7 percent from a year earlier. The supply uncertainties appear to have driven Arizona prices for slaughter steer and heifers significantly higher during 2003; prices remain about 17.6 percent higher than those of a year earlier.

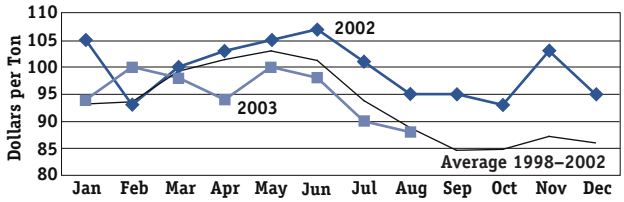
Continued on page 20.

Arizona Upland Cotton Prices



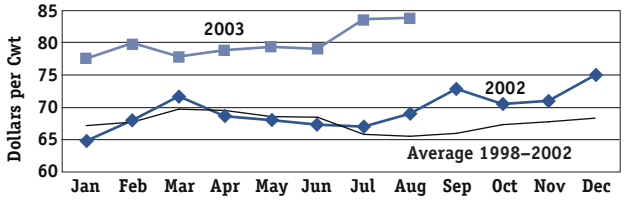
Source: AMS; 31-3-35 cotton prices for desert southwest

Arizona Alfalfa Prices



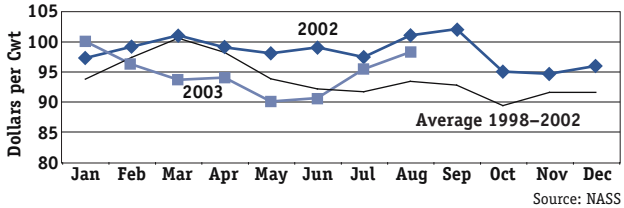
Source: NASS

Arizona Slaughter Steer and Heifer Prices



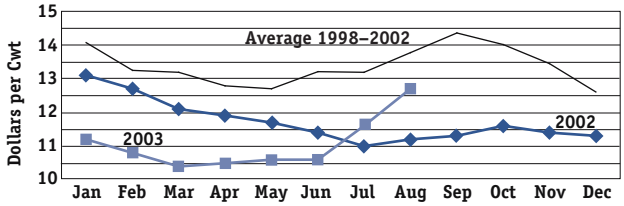
Source: NASS

Arizona Calf Prices



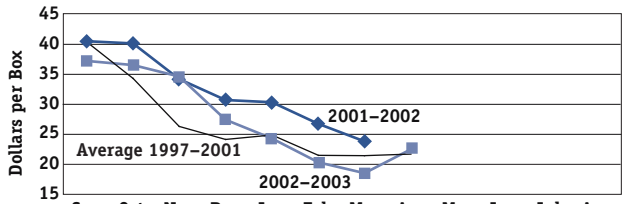
Source: NASS

Arizona Milk Prices



Source: NASS

Arizona Lemon Prices



Source: NASS

New Technologies, IPM Reduce Pesticide Use in Arizona Cotton

George B. Frisvold
frisvold@ag.arizona.edu
Professor and Extension Specialist
Agricultural and Resource Economics
University of Arizona

Pest control and pest damage cost U.S. cotton growers over $1 billion dollars per year. Although it accounts for far less acreage than corn, wheat, or soybeans, cotton is often the single largest user of insecticides in the United States. Insects infest cotton to a greater extent than other field crops. Grown in warmer climates, cotton has a longer growing season and higher winter survival rates of insect eggs and larvae. Because of greater pest pressure, cotton production has been relatively pesticide intensive. For example, in 1997, cotton accounted for just 4 percent of U.S. cropland, but a third of the total quantity of insecticides used.

In recent years, Arizona cotton growers have been able to dramatically reduce their use of insecticides by adopting new pest control products and integrated pest management practices. To become available, these products had to clear a number of regulatory hurdles. University of Arizona research has been instrumental in speeding these new products to market and maintaining their effective use.

By Every Measure, Insecticide Use Falling

There are three major sources of data on insecticide use in Arizona cotton. First, USDA's National Agricultural Statistical Service maintains the *Chemical Use Database,* which provides information about insecticide use for selected crops and states. Second, the *Beltwide Cotton Insect Losses Survey* (CIL survey), supported by the National Cotton Council, provides estimates of cotton pest control costs and pest damages. The third source of data comes from the Arizona Department of Agriculture L1080 form. The state of Arizona mandates reporting of pesticide applications by commercial applicators, pesticides included on the Arizona Department of Environmental Quality Groundwater Protection List and pesticides used under special emergency registration by the EPA.

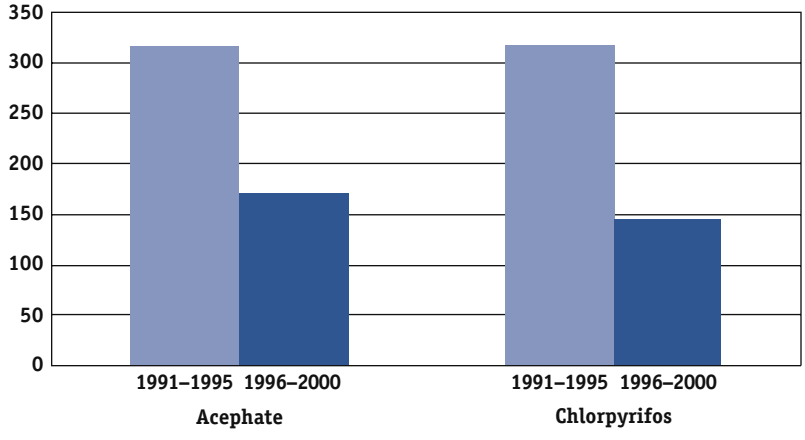
These surveys measure insecticide use in different ways, reporting acres treated, pounds of active ingredient applied, number of applications, or a dose-adjusted measure of applications. Despite differences in measurement, the three data sources tell the same overall story. From the first half of the 1990s to the second half, the physical quantity of insecticides used on Arizona cotton was cut in half.

To illustrate, acephate and chlorpyrifos are among the most commonly used insecticides in Arizona cotton production. According to USDA data, over 300 million pounds per year of each active ingredient were applied on average to Arizona cotton from 1991–1995. From 1996–2000, though, applications fell to around 150 million pounds per year each.

Over this period, the price of cotton fell substantially—from over 70 cents per pound in 1995 to less than 40 cents per pound by 2000. With falling prices, cotton acreage in the state also fell. This raises the questions: How much of the fall in insecticide use came about because of lower application rates (fewer applications per acre) and how much came about from cotton acreage taken out of production?

It turns out that acreage reduction accounted for just 24 percent of the overall reduction in pounds of acephate used and 15 percent of the reduction in pounds of chlorpyrifos used. The remainder of the reduction came about because growers applied less of these chemicals per acre. Data from the CIL surveys and the L1080 forms also show that application rates have been substantially lower since 1995.

Million Pounds of Active Ingredient Applied per Year to Arizona Cotton, 1991–1995 Average vs. 1996–2000 Average



Source: USDA, NASS Chemical Use Survey

Why Has Insecticide Use Fallen?

The main pests of Arizona cotton have been pink bollworm, whiteflies, and lygus bugs. These three

pests accounted for the bulk of cotton pest damage and control costs in the early 1990s. In 1996, new pest control products became commercially available in Arizona: Bt cotton for pink bollworm and insect growth regulators (IGRs) for whiteflies.

Bt stands for *Bacillus thuringiensis,* a naturally occurring soil bacterium that produces a protein toxic to certain insects, but not—the EPA has determined—to humans or other species. Through genetic engineering, material from Bt is implanted into cotton plants, enabling them to produce the Bt toxin that controls pink bollworm and other insect pests. While Bt seed saves on conventional insecticide sprays, seed suppliers charge a price premium or "technology fee" of roughly $30 per acre.

Based on insect hormones, insect growth regulators disrupt the development of particular insects. While many conventional insecticides broadly target nervous systems, IGRs selectively target insect-specific growth functions and usually are not broadly toxic to birds or mammals.

Arizona growers quickly adopted these new technologies. In 1996, IGRs were applied to about two-thirds of cotton acreage, while Bt cotton accounted for about two-thirds of state cotton acreage by 1997. Use of both has declined in subsequent years, in part because of more effective control of pink bollworm and whitefly populations. By switching to Bt cotton and IGRs, growers have been able to reduce their overall insecticide use. Chemical sprays for whiteflies dropped from 3.6 insecticide applications per year from 1990–1995 to less than 1.2 from 1996–2002. Over the same periods, chemical sprays for pink bollworm fell from 2.7 applications to an average of 0.7 applications per year.

Public–Private Collaboration to Deploy New Technologies

The private sector initially developed and patented Bt cotton and IGRs. Yet, many steps are needed to take a product from the laboratory to successful use by growers. Product performance must be tested objectively under realistic field conditions. Research must be conducted to assess environmental impacts and to support regulatory approval. Products need to fit within an overall pest management system. Practices need to be put in place to prevent the development of pest resistance to the new products. These many phases from laboratory to field involved private sector collaboration with the University of Arizona College of Agriculture and Life Sciences (CALS), USDA, the Arizona Cotton Growers' Association, Arizona Cotton Research and Protection Council, and Cotton Incorporated.

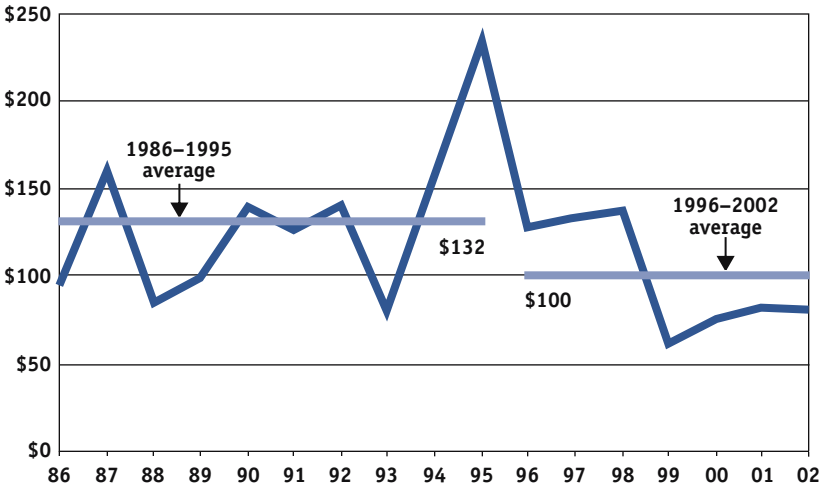
Arizona cotton growers experienced severe whitefly infestations in 1992 and again in 1995. By 1995, whiteflies showed signs of significant resistance to certain conventional insecticides. In the most affected areas, growers made 8 to 12 applications, with costs ranging from $200 to $300 per acre without necessarily controlling pest damage. In 1995, grower organizations, private firms, USDA, and CALS collaborated to gain rapid EPA approval to use IGRs to control whiteflies. Various types of research were needed to support the application for approval. First, laboratory bioassays from the Extension Arthropod Resistance Management Laboratory of the University of Arizona were used to demonstrate to regulators that whitefly resistance to currently available insecticides was developing. Second, data on impacts of reduced efficacy of conventional control methods on control costs, lint quality, and cotton prices were compiled to demonstrate the economic severity of the problem. Third, field trials on the efficacy of the IGRs were conducted. Fourth, the application required that Arizona develop an integrated resistance management plan to prevent pest resistance to the IGRs. Finally, results of toxicological studies of the properties of the IGRs had to be submitted. Following these research activities, much of which was conducted by CALS faculty, EPA approved two IGRs in time for the 1996 crop year. But the story does not end when products are approved.

Arizona was among the first field test sites for Bt cotton in the United States. Field tests were carried out by USDA and Monsanto at the University of Arizona Maricopa Agricultural Center in 1990. EPA regulates plants, such as Bt cotton, that are genetically engineered to control pests as pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). FIFRA is what is known as a "balancing" law. EPA must make decisions whether or not to approve use of Bt cotton and other transgenic crops by comparing risks they may pose with the benefits they provide for growers and consumers. In 2001, EPA renewed registration of Bt cotton for 5 more years, after a yearlong assessment of its risks and benefits. EPA's Science Advisory Panel relied on analyses conducted by University of Arizona entomologists and agricultural economists, among others, in forming their recommendations.

Economic Impacts

From 1986 to 1995, Arizona cotton growers spent an average of $132 per acre to control pests (this, in 2000 inflation-adjusted dollars). From 1996 to 2002, per acre costs—including Bt cotton technology fees—averaged $100 per acre. Statewide, this per-acre cost saving translates into roughly $9 million per year, or about $14,000 per cotton-growing farm per year.

Costs per Acre of Cotton Pest Control in Arizona Including Bt Cotton Technology Fees (in 2000 Constant Dollars)



Source: Cotton Insect Losses Survey

Sustaining Economic and Environmental Benefits

Farming profitably and protecting the environment are often portrayed as being at odds. Yet, Arizona's recent success in cotton pest management shows that it is possible to reduce insecticide use, improve pest control, and lower farming costs, all at the same time. New pest control products have succeeded in Arizona because they have been successfully incorporated into a broader integrated pest management system. Ongoing research and extension seeks to sustain these benefits by wisely managing the use of these products to prevent the onset of resistance. AR

Pest Control Data Sources

USDA National Agricultural Statistical Service Chemical Use Database:

http://www.pestmanagement.info/nass/

Beltwide Cotton Insect Loss Database:

http://ag.Arizona.edu/crops/cotton/insects/

For publications using Arizona Department of Agriculture L1080 data:

http://ag.arizona.edu/pito/az_pmc/azpmc.htm

George Frisvold *conducts research and outreach on environmental policies and natural resource management issues of importance to Arizona. His program includes ongoing work on agricultural biotechnology, pesticide use and regulation, border environmental management, and the relationship between federal farm programs and resource use.*

Butler continued from page 1.

the multiplicity of government statutes regarding pesticides, food safety, and the environment.

Nearly 325 ADA staff—more than half located outside Phoenix—work to carry out ADA responsibilities. The Department is divided into three divisions: Plant Services, Environmental Services, and Animal Services Divisions.

By way of an example of our responsibilities, the Department cooperates with the federal government to inspect both plants and animals entering Arizona through its various ports of entry—and especially along our borders with Mexico, California, and New Mexico. This is a huge job, and of course relates directly to protecting our food supply for consumers and plant and animal "imports" for our agricultural and horticultural sectors.

The ADA will undergo some changes. We will work to give more direction and focus to the Department. To this end I have asked the senior leadership to develop goals for their units, and they have responded with enthusiasm. I am working to lift morale among our staff—especially in these early weeks of my tenure. I have personally visited with not only Phoenix staff, but also many in the field. They appreciate the opportunity to air their views! And I enjoy seeing them eyeball-to-eyeball. The Department should be a friendly place to work and be served. I also am working to increase federal grant monies coming into the Department. Those funds are out there, we need our share. I also want to use my past associations with people now in the secretary's office of the USDA in Washington to foster Arizona's agricultural interests.

Arizona Review. *Currently, what key issues face Arizona agriculture?*

Butler. Food safety, as I suggested earlier, worries many people. The consumer can buy nearly anything in the supermarket, but has little idea of all that's gone into the production of that supermarket product. We need to do a better job of education to inform the public of steps taken to ensure food safety.

Plant and animal health issues continually confront agriculture. Right now it's the West Nile virus.

Agro-terrorism now receives some of our attention. We have veterinarians, for example, working to help prevent disease through terrorist activities.

Water will continue to be an issue. Always has been. Always will be.

Pesticides, dust, and odors cause concern, especially in a rapidly urbanizing state such as ours. I marvel at the urbanization of agricultural land in the Phoenix area. Now new houses and golf courses are springing up near Casa Grande on land that until recently produced high-yielding crops. Developers are building new houses on the borders of Big Mac, the major University

of Arizona research and demonstration farm near rural Maricopa. People in these newly urban areas will not like the smells, dust, and chemicals that have historically been associated with the nearby farmland.

Arizona Review. *How will the ADA address these issues?*

Butler. You might think of pigeonholing each issue into one or more of our three divisions—Plant Services, Environmental Services, or Animal Services. Pesticide and dust issues, for example, might be addressed by our plant or environmental divisions. They license pesticides and pesticide applicators, and perform inspections to insure compliance with pesticide and dust regulations. Our animal division would address concerns about animal health, such as the West Nile virus issue. They work to help prevent infected animals from entering, in part by inspecting and issuing certificates of entry at border crossings. Our Animal Services Division is also working with Homeland Security and with counterparts in Mexico to avert security problems along our border with Mexico.

Arizona Review. *What about the long-term future for Arizona agriculture? How do you see agriculture evolving over the next 10 to 20 years?*

Butler. I hate to make a prediction. Think about all the change in Arizona agriculture just since the Second World War. Could we have foreseen that change in 1945? Agriculture is changing even faster now, clouding our crystal balls. Even our good friend Bartley Cardon, himself intimately tied to Arizona agriculture and the changes that have taken place, hesitates to predict its future.

Having said that, I do see a continuation of trends that are sure to affect production agriculture. We have already talked about some of them. Urbanization seems certain to continue, using both land and water that formerly produced crops and livestock. Might these forces prompt more greenhouses and drip irrigation? Surely we can expect more crises, although we have no idea what those crises might be. Crises seem to spur innovation. Take the drought. One innovative company now uses government surplus powered milk to manufacture nutrient blocks for drought-stressed range cattle. International trade has gotten easier, will continue to get easier, and trade will continue expanding.

Arizona Review. *Do you see any opportunities for expanded agricultural trade with Mexico? Other countries?*

Butler. For some time, even predating NAFTA, few quotas or tariffs impeded the shipment of feeder calves from Mexico to our feedlots. Now we are seeing the development of government health protocols and huge oceangoing ships (some to hold 35,000 feeder calves weighing 500 pounds) that, given favorable exchange rates, will encourage importation of feeder calves from even distant countries such as Australia.

Arizona Review. *Given Arizona's rapidly expanding urban population, what suggestions do you have for allocating our limited water?*

Butler. Information from the Salt River Project suggests that as Phoenix expands onto agricultural land, the new urban areas use approximately the same amount of water as farmers had used for irrigation. Yes, the same water serves more families, but I still see water that seems wasted. As I drive to work on Fifteenth Avenue, flood irrigation waters lawns, and often part of the water runs down the gutter. Tucson, my home city, seems to do a better job of water conservation. Quite likely low-priced water in Phoenix and high-priced water in Tucson explains the difference in water conservation.

Arizona Review. *How might ADA and the College of Agriculture and Life Sciences (CALS) at the University of Arizona cooperate to better serve our consumer and agricultural audiences?*

Butler. As I mentioned earlier, several Department activities aim to better serve consumers. I think both ADA and CALS can do a better job with consumer education. We need to help consumers understand agricultural production and food processing, including the considerable effort that goes into assuring food safety.

I see other ways for ADA and CALS to cooperate. I have heard about the fine workshops that agricultural economists and others have sponsored for Arizona's ranchers. I would like to see our ADA cattle inspectors participate in those workshops. What a great opportunity for better communication among ranchers, a government agency often interfacing with the ranchers, and our land grant university.

Here's another possibility. Perhaps CALS and ADA diagnostic labs can share expertise and facilities. Especially in these budget-short times I think we need to foster cooperation.

Arizona Review. *Thank you, Don. We do indeed look forward to working with you and the Arizona Department of Agriculture. We wish you well in these exciting and yet challenging times for the Department.* AR

Arizona's Ag Situation continued from page 15.

During July and August 2003, wholesale cheese and butter prices increased significantly. The result is that farm milk prices are headed up. This comes as a relief to dairy farmers after near record low milk prices in 2002 and the first six months of 2003. The worsening drought situation and low milk prices have resulted in reductions in the number of milk cows, and the long-awaited downturn in total milk production appears to have finally come.

Arizona is the second largest lemon producer in the U.S., behind California. Although Arizona production in 2002–2003 remained the same as last season's at 106,000 tons, production has increased nationally by about 18 percent. Due to the larger crop this year, lemon prices have averaged 13 percent less than those of last season. AR

Satheesh Aradhyula's *research shows how agricultural policies affect producers and consumers. He also studies agricultural trade between the U.S. and Mexico, the role of risk in farm production decisions, and issues related to the agricultural sectors of developing countries. Satheesh teaches commodity price analysis and advanced econometrics courses at the University of Arizona.*

New at AREC and the Cardon Endowment Program

Aradhyula, Satheesh and Russell Tronstad. "Does Tourism Promote Cross-Border Trade?" *American Journal of Agricultural Economics* 85(3):569–579. August 2003.

Cory, Dennis and Anna Rita Germani. "Criminal Sanctions for Agricultural Violations of the Clean Water Act," *Water Policy* 4:491–514. 2002.

Frisvold, George B., John Sullivan, and Anton Raneses. "Genetic Improvements in Major US Crops: The Size and Distribution of Benefits," *Agricultural Economics* 28(2):109–119. 2003.

Frisvold, George B. and Daniel Osgood. "Ambos Nogales: A Tale of Two Cities and Water Management on the U.S.-Mexico Border," *Journal of Law and Border Studies* 2:7–36. 2003.

Frisvold, George B. and Russell Tronstad. "Global Impacts of Bt Cotton," in *Proceedings of the Beltwide Cotton Conference,* pp. 333–347. National Cotton Council, Memphis. 2003.

Megdal, Sharon. "Public Policy Review," a regular column on water policy issues in *Arizona Water Resource,* the bi-monthly newsletter of the Water Resources Research Center, University of Arizona, and online at **http://www.ag.arizona.edu/AZWATER/awr/awrmain.html**.

Tronstad, Russell and Trent Teegerstrom. "Economic Trade-Offs Between Sale Weight, Herd Size, Supplementation, and Seasonal Factors." *Journal of Range Management,* Economics Section 56(4):425–431. September 2003.

Tronstad, Russell, Jeff Silvertooth, and Steve Husman. "Irrigation Termination of Upland: An Economic Analysis of Yield, Quality, and Market Factors." *Journal of Cotton Science,* Economics and Marketing Section 7(3):86–94. 2003.

Wilson, Paul and Gary Thompson. "Time Integration: Agribusiness Structure for Competitive Advantage," *Review of Agricultural Economics* 25:30–43. 2003.

Wilson, Paul. "Water Valuation Principles for Emerging Global Water Conflicts." In *Proceedings of the First International Symposium on Transboundary Waters Management,* edited by A.A. Aldama and others, pp. 11–20. Mexico: AMH-IMTA. 2002.

Wilson, Paul. "Economic Science and the Central Arizona Project: Lessons Learned," *Water Resources Update* 123:30–37. June 2002.

Visit the AREC web site at **http://ag.arizona.edu/arec/** for online publications, including the *2002 Arizona Field and Vegetable Crop Budgets, Arizona Ranchers' Management Guide, Cotton Newsletters,* and other publications related to the economics of Arizona's agriculture and natural resources.

ArizonaReview
economic perspectives on Arizona's agriculture and natural resources

Agricultural and Resource Economics
College of Agriculture and Life Sciences
The University of Arizona
PO Box 210023
Tucson, Arizona 85721-0023

NON-PROFIT ORG.
U.S. POSTAGE
PAID
TUCSON, ARIZONA
PERMIT NO. 190

The Cardon Endowment
for Agricultural Economics and Policy
Department of Agricultural and Resource Economics