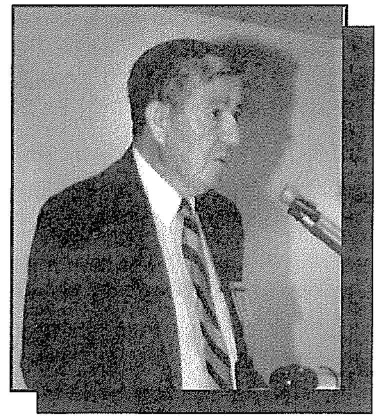
Woods Houghton *is a fourth generation New Mexican, born in Albuquerque and raised doing ranch and farm work. He received both bachelor's and master's degrees from New Mexico State University. He is a board certified entomologist by the Entomological Society of America and a certified crop advisor by the American Society of Agronomy. Woods' work experience includes twelve years as a county extension agriculture agent in Eddy and De Baca counties, eight years as a research assistant with NMSU, twenty-five years as a farrier (horse-shoer) and thirty years as a farm and ranch hand.*

Scotty Savage *was raised on a ranch in Texas between Pecos and Carlsbad. She graduated with a master's degree in range nutrition in 1975 and began working with the Soil Conservation Service the next year. Scotty has worked in the field of water development and irrigation conservation in eastern New Mexico for 21 years. Currently she is working on promoting LEPA irrigation systems and education in the area of rainfall enhancement. She has a very strong conviction that these two approaches in addressing the critical decline in the Ogallala Aquifer may be a very big part of the solution that is being sought.*

Robert Faubion *is a 1980 graduate of New Mexico State University with two B.S. degrees, one in agricultural economics and the other in animal husbandry. He farms cotton, chile, lettuce and corn silage in the Mesilla Valley. Robert serves on the Board of Directors of the New Mexico Farm and Livestock Bureau and has served on various other boards and committees including the Constitutional Revision Commission.*

Palemon Martinez is a member of the Interstate Stream Commission and serves on two of its subcommittees on Regional Water Planning and the Rio Grande. Palemon is the President of the Taos Valley Acequia Association and President of the Taos Valley Water Commission. He also is a member and secretary/treasurer of the Northern New Mexico Stockman's Association. Palemon is a farmer and rancher with B.S. and M.A. degrees in agricultural education from NMSU.



AGRICULTURAL WATER CONSERVATION PANEL

Woods Houghton
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Agriculture—a lot has been said at this conference on the subject of taking water from agriculture and moving it to municipal and industrial uses. Agriculture is not some ambiguous black hole we pour water into without a return. The way it has been spoken of here and in most meetings like this, one would think this thing called "agriculture" consumes 85 percent of New Mexico's water, depriving others of its use, with few benefits. Agriculture is a 1.5 billion-dollar industry in New Mexico. That is roughly 82.5 semi-truck loads of dollar bills or 30 percent of the economy of this great state.

We are all involved in agriculture, either as consumers or producers. Everyone who eats food is an active participant in agriculture. So agriculture is not a black hole into which we pour water. When we consume agricultural products like an ear of corn, we consume the 150 or so gallons of water it took to produce that ear of corn. People, urban and rural, are the ultimate consumers of agricultural water.

When we reduce agriculture production, anywhere, we reduce the number of people supported by the food production system. The human race is not exempt from the law of nature we in agriculture call "carrying capacity." That is, a population will grow until it reaches or exceeds its limiting factor at which point that population will crash. Although New Mexico makes up less then 5 percent of the national agriculture output, this discussion of taking water from agricultural use for urban use is occurring in agricultural rich states like California, Arizona, Utah, Colorado, Texas, and in other countries as well.

The fact is that wildlife, agricultural production, economic growth, and human population in the arid southwest is limited by water availability. We are at our maximum carrying capacity and must face some hard decisions that every rancher makes every day. Do we limit the growth of our herd? Do we reduce our herd by culling those less productive? Do we seek other sources of resources to sustain growth?

The animals in this herd are human, which makes it much more difficult, but the principles are the same. As a side note, the economy of this nation—or for that matter the world—is driven by two factors. One is the low cost of food and the other is the low cost of energy. If food costs had kept pace with inflation, the average family today would be paying 10-20 percent more for their food. Instead, in 1950, food was 18 percent of the family budget and in 1990 food was less then 10 percent of the family budget. This frees money for expenditure on other things. The same is true for energy costs. The point is that anything that increases the cost of food, will have a large impact on the economy.

Water conservation is important but does not always mean less water use. Conservation can mean the greatest return per unit of water invested that is possible. Because the profitability of an agricultural production business is dependent on cost-to-benefit ratios or in simple words, getting the maximum production with minimum input, agriculture producers have been involved in water conservation for a long time. According to an agricultural economist at New Mexico State University, irrigation costs account for 30 percent or more of an average agriculture producers' production costs. When that cost can be reduced, it has a direct effect on profitability. If we look at the history of agriculture in New Mexico and in particular, the eastern side of New Mexico, that is apparent.

It is generally assumed that because agriculture uses so much water, agriculture is wasteful and water could be recovered by implementing agricultural conservation practices. It has been my experience when talking with people not in the agriculture sector about water conservation, that what they call conservation of water is actually increased efficiency not conservation. From a purely academic standpoint, the only water used by agriculture to produce a crop is the consumptive use of that crop. All other water is lost in delivery or application.

From my experience working as a county agent with producers in two New Mexico counties, producers are implementing conservation practices that increase delivery and application efficiency as those practices become economically and technologically feasible. It must be remembered that "Agriculture Production" is a business and a capital outlay has to result in an amortized payback or it becomes an unfeasible, unprofitable input cost.

Most, if not all, agricultural production lands have a conservation plan. Plans are derived from a variety of sources although the most common come from the Natural Resources Conservation Service (NRCS). NRCS plans were mandated by the 1985 Food Securities Act whereby agricultural producers were required to implement a conservation plan if the producer wanted to participate in U.S. Department of Agriculture (USDA) farm programs. The plans are farm specific, taking into account the many variables that affect water and soil conservation, including the water source and quality, soil type, cropping patterns, topography, climate and practical feasibility. The plans do not take into account business parameters such as profitability in a direct manner. Plans are developed utilizing expertise from the NRCS and other agencies such as the county Cooperative Extension Service.

If an agriculture producer does not agree with an NRCS plan, feels it incomplete, or just wants a second option, they can have a site-specific conservation plan developed for them. Plans have been developed by private consultants, other agencies such as the Cooperative Extension Service, or if the land is leased from a federal or state agency, that leasing agency can develop a plan in cooperation with the producer. For example, management plans have been developed in cooperation with the Bureau of Land Management and New Mexico State Land Office. If a producer chooses not to participate in USDA programs, he does not have to develop a plan. However, many banks require a management plan to issue operation loans.

Current technologies used for agriculture production are dependent on that most crucial 15-pound computer that rests on the producer's shoulders. Agriculture is still an art and a science, and no matter how good the science is, the art of applying that science is developed with time and experience. My father once told me that common sense was directly proportional to mistakes made and from which something was learned from those mistakes. Technologies are only as good as the art of application and the person behind that art. Technology must be applied with common sense and adapted to the experience base of the person applying it. The crop will have to pay for the technology unless outside funds are available.

The goals of water conservation are really quite simple. The first goal is to apply only the amount of water that the crop can put to beneficial use before the next irrigation. In other words, if it is not possible to irrigate every day, some overwatering will occur. This is one reason drip irrigation is so efficient—it reduces nonconsumptive use to a small amount. This reduction also lessens the amount of return flow to the aquifer and the leaching of nutrients and salt. The second goal is to apply irrigation water uniformly. This is simple to state but not always simple to implement. The third goal is to match crops and soils with the amount and type of water application. The fourth goal is for the agriculture producer to make a profit. With these goals in mind, let's look at the types of technologies in use.

The most common technology is engineered irrigation systems and includes diversion, conveyance, and application. The diversion can involve groundwater via a well or surface water via a dam. Well efficiency is important for groundwater diversions. The depth, size, and formation from which the water comes can affect the efficiency of the diversion. The closer the diversion is to the application site, the more efficient the conveyance system. The conveyance method can be a pipeline, which is most efficient, concrete ditches, or open dirt ditches, which are least efficient. With the advent of inexpensive rolled mill plastic pipes that fit into the dirt, unlined ditches, these should be a thing of the past.

The application method may be flood, sprinkler, or subsurface (drip). Flood irrigation is the most common method of application. Studies from the University of California at Davis indicate properly engineered and leveled fields may be as efficient in delivery as many sprinkler systems. Leveling may be accomplished in many ways with laser leveling being the least expensive and the fastest to implement. A laser beam is employed to raise and lower the land plane used in leveling. Other methods of leveling are as accurate but usually are more time consuming and require more fuel to accomplish the same standard. The fall in a field is dependent on the delivery head, the soil type, crop, and length of run. The NRCS has been and hopefully will continue to be the major source of engineering expertise. Their staff has developed standards and guidelines for developing an engineered system with minimal soil loss and the most efficient water distribution based on a large number of site specific parameters.

Other delivery systems can modify the flood system. These include furrow irrigation which is best adaptable to row crops. The furrows may be diked to slow water flow and retain natural rainfall, or torpedoed to speed water flow to the other end of the field quickly. Although these methods are at either end of the spectrum, if applied correctly to the appropriate fields and under the right soil conditions, both will increase water efficiency. If applied under the wrong conditions and soils, they will likely cause an increase in water inefficiency and soil erosion. Other delivery and application improvements include surge flow irrigation, and gated pipe.

Sprinkler systems can include center pivot, low energy precision application systems (LEPA), side row, and stationary systems. These can be low pressure or high pressure systems. Each of these systems have some advantages and disadvantages depending on the site requirements of the application. An entire conference could be devoted to describing agriculture water conservation. What I want to convey is the idea that no matter what technology is used, it must be site specific in planning and application. Used correctly it can reduce conveyance and delivery losses, used incorrectly it may increase conveyance and delivery losses.

Drip irrigation is the most efficient delivery and application method available under current technology. Drip irrigation supplies water in small amounts as the plant needs it. It is very expensive to install and operate and may not be adaptable to many areas due to water quality and other parameters. Also because it reduces water losses in delivery and application, it may reduce the recharge to the hydrologic system. This could, under some circumstances, impair another's water rights.

The next major concept concerns applying water when the crop needs it. Scheduling is the output of the "computer" on the producer's shoulders. Collecting the data to help the producer make scheduling decisions can occur in many ways; mechanical aids such as soil augers, evaporation pans, tensiometers, and gypsum blocks can be used or shovel and hand test for the feel of the soil. Computer programs can assist in evaluating a number of parameters and help predict when water application is needed. Like other technologies I have described, these scheduling devices must be properly placed and maintained and are not applicable to all situations.

With an ever-increasing population, world leaders are again looking to further develop irrigation on semiarid and arid lands which comprises over half the earth's land surface. Today more than 60 percent of the world's population is dependent on food produced under irrigation. With the extensive planning of individual fields and farms by the NRCS, we must keep in mind the idea that integrated planning will give maximum production on irrigated farms with minimum input needs to be further pursued.

Technologies are only a part of the integrated planning that must occur. Other considerations include soil-water relationships, salt, alkali, soil physical properties, organic matter, crop rotations, fertilizers, and irrigation practical practices. Farm planning must bring together the work of soil scientists, engineers, crop scientists, livestock specialists, landscape specialists, and economists with due regard for the interests and abilities of the agriculture producer. Their combined energy must be directed toward solving practical farm problems.

In our haste to downsize government, we reduce funding to strategically important agencies such as the NRCS, the Cooperative Extension Service and on-farm conservation programs administered by the Farm Service Agency, formally the Agricultural Stabilization and Conservation Service (ASCS). It is in the public's best interest, not just agriculture producers, to maintain strong technical, educational, and economic assistance for agricultural water conservation.

Scotty Savage
Natural Resources Conservation Service
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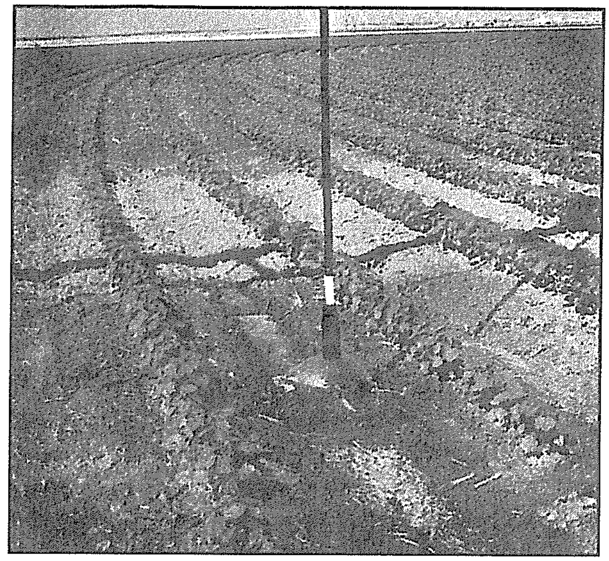
The Ogallala Aquifer encompasses 176,940 square miles across the Great Plains. It is the world's largest aquifer by volume. The Great Plains, long known as "the breadbasket of the world," gained this reputation for the vast amounts of grain grown annually. This is made possible by the existence of the Ogallala.

The Ogallala serves 53 percent of the irrigated acres in New Mexico and is responsible for a large percent of the agri-dollars generated for the state.

Recharge to the aquifer is very slow and the Ogallala is being depleted at an alarming rate. If we do not find the pieces to this water puzzle, the Ogallala will one day be gone. One very important piece to this puzzle is water conservation. Conservation will not "save" the Ogallala but it can help extend its life until the rest of the puzzle is solved.

Since most of the land irrigated from the Ogallala is irrigated with a center pivot system, that is where we must first look for the greatest potential for savings. The most efficient system on the market today is not just a kind of a sprinkler but is a method of irrigation as well. It is known as a Low Energy Precision Application System (LEPA).



The LEPA system has many advantages over a conventional system. It is designed to farm the land in a circular pattern so that water may be placed in every other furrow directly on the soil surface. LEPA operates at very low pressures (6-10 psi at the nozzle) and thus less water is pumped. Storage basins allow higher rates of application so the system can travel faster resulting in more frequent irrigations. A plant watered more frequently will yield more than a plant receiving fewer irrigations, even though the total amount of water applied is the same.

The greatest advantage to LEPA is in cutting water losses. LEPA is 95-99 percent efficient. Most conventional systems are 60-65 percent efficient, and that figure plunges when you add a 10 mph wind. Most conventional systems wet 100 percent of the soil surface and all the leaf surface. With LEPA, canopy evaporation is virtually eliminated. Soil surface evaporation losses are cut by more than 50 percent since water is applied in every other row. Misting with a conventional system is very susceptible to wind drift. With LEPA, no misting occurs. With a conventional system topography, poor tillage and over irrigating increase runoff losses. With a LEPA system, tillage practices and system management reduce the potential for runoff. Over watering often results in deep percolation and losses below the soil surface. Soil moisture monitoring helps eliminate these losses with a LEPA system.

How much savings could we experience? There are approximately 1,600 center pivots in Roosevelt and Curry counties covering about 200,000 acres. The consumptive use (CU) of common crops grown is about 20 acre inches per year.

	Conventional	LEPA
System efficiency	60%	99%
Acre inches needed to meet CU	33 acre inches	20 acre inches

This is a loss of 13 acre inches per acre! Or a loss of 2.6 million acre inches over the 200,000 acres!! If all 1,600 pivots were LEPA systems, we would save enough water annually to irrigate another 130,000 acres per year. Over a 10-year period this water savings would produce 78 million bushels of wheat or 1.3 trillion pounds of corn.

I began by saying we must search for all the pieces to this puzzle. Not because the state of New Mexico will lose some very important tax dollars, but because individuals make their living from the Ogallala and these individuals have families, families who live in communities. These communities make up the schools, churches and businesses who depend on the income generated from the Ogallala. We must continue to work until all of the pieces of this puzzle are put into place. Today you have had the opportunity to hear what I believe are perhaps the most important puzzle parts. The first being weather enhancement and second being conservation with LEPA. It is people like you who have taken time from your busy schedules and who will take these ideas today, improve and refine them, and help us to find all the pieces of the Ogallala puzzle. I look forward to that time.

Robert Faubion
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I would like to thank the Water Resources Research Institute for inviting me here today. In looking over the crowd and seeing all the water professionals here today as well as the water experts serving on this panel, as a farmer, I feel a little bit like the cowboy who was asked to give a sermon at a convention of preachers. I will try to keep my comments short and to the point today.

I, too, will discuss a bit about implementing water-saving mechanisms in agriculture. We furrow irrigate on my farm north of Las Cruces. Water is delivered to us from Elephant Butte Irrigation District and we utilize shallow well water. We raise a wide variety of crops including cotton, chile, lettuce, cabbage, onions, wheat, corn, alfalfa and pecans.

Three years ago on one of my farms, I installed approximately 350 acre-feet of subsurface drip irrigation system. You might ask yourself why I would need to install a water conservation system in an area where, relatively speaking, we have plenty of water. The answer is that this particular farm was a high water user. It required a lot of water to raise crops and it was my lowest producing farm. The water conservation system has paid for itself or is in the process of paying for itself. That particular farm now has become my highest yielding cotton farm. I use approximately half the water on that farm as I use on my standard flood-irrigated farms.

We water at high frequency. It has been mentioned that the higher the frequency and the more timely the application, the more beneficial it is to the crop—and we have found that to be true—higher yields have resulted. Whether we talk about a surface or subsurface drip irrigation system, or a LEPA (Low Energy Precision Application), or any agricultural water conservation system, they all require certain things. They usually are fairly expensive to install, some more than others. A drip irrigation system can run in excess of $1,000 per acre. That cost is awfully hard to justify when you are farming land that may be worth only $500 per acre. The system also requires a bit higher level of management. Each individual user will have to decide what is best for him and then live with that decision.

The big drawback with any of these water-conserving systems is the financial return to the grower or water user. There must be a financial incentive whether it is the user achieving higher yields, which most of the systems if used properly can provide, or in some other fashion, such as in our area, the sale of conserved water to another use.

At this meeting, we have discussed water use throughout the state, not only agricultural use but also municipal and industrial use. In our area of the state, we are wrestling with the dilemma of how to transfer water from agricultural use—where it traditionally has been used—to municipal and industrial use. We know agricultural water is going to be transferred to municipal and industrial uses.

I think, from my simplistic farmer viewpoint, that the marketplace is probably the best mechanism by which to transfer water, rather than a government entity of any type. Let the market encourage agricultural producers to conserve water and sell it for a profit. That is the key and that is what I believe will aid in getting water transferred to where we know it is going to go eventually.

I also would like to stress that, in my personal opinion, the concepts of governmental incentives, whether they be tax incentives or other kinds of incentives, for producers to utilize these water-saving strategies and equipment, will work. Currently financial rewards or incentives are not large enough. However, I think we can do it. I know a number of individuals in my area who are installing subsurface drip systems. In a majority of those instances, they are combating a lack of water. In my case and for some others in the valley, we are installing the systems for other specific reasons. The main point is that there are mechanisms available to affect a savings in water, and hopefully we can direct that water through the marketplace to its highest and best use.

Palemon Martinez
New Mexico Interstate Stream Commission
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Being up here reminds me of when the leader of a large organization once said, "I will try my very best, but my very best isn't very good." I want to cover two main items today. The first item I'll cover from an Interstate Stream Commissioner's standpoint who also is a major agricultural water conservation player *through* the Irrigation Works Construction Fund. The Irrigation Works Construction Fund was first funded by the Ferguson Act almost 100 years ago in 1898. Let me read to you what the fund does.

> The Irrigation Works Construction Fund plays a large part in the Commission affairs. Throughout the year loans are made available to acequias, conservancy and irrigation districts on a need basis. The Secretary of the Commission has been delegated the authority to make such loans as long as the loans do not exceed $25,000, and the total indebtedness of the organization requesting the loan does not exceed $50,000. In conjunction with our own program, the Legislature appropriates about $200,000 each year to the State Engineer for grants to the acequias as a state cost-share part of the program. The creation of irrigation and similar districts authorized by New Mexico law has been useful in carrying out projects for distribution and conservation of water. Under the conservation programs for irrigation purposes, the Commission approved annual contracts most recently for the following districts: Pecos Valley Artesian Conservancy District, Arch Hurley Conservancy District, Elephant Butte Irrigation District, Caballo Soil and Water Conservation District, Carlsbad Soil and Water Conservation District, Roosevelt Soil and Water Conservation District, Sierra Soil and Water Conservation District, Tierra y Montes and Upper Hondo Soil and Water Conser-ation districts.

The funds are loaned under contract to the districts and are in turn reloaned to the individual water users for constructing and rehabilitating on-farm irrigation works. The funds have been used for such purposes as leveling of irrigated lands, lining of irrigation ditches, installation of underground irrigation and sprinkler systems, drilling and equipping irrigation wells, meter installations and other similar water conservation practices. This aspect of the loan program might be considered the state's major conservation program.

The Irrigation Works Construction Fund provides for an interaction with federal agencies. Each year a contract is entered into with the Natural Resources Conservation Service to provide technical assistance and to provide design improvements for acequias. The amount of the last proposed contract is $250,000. Also provided from the fund is the nonfederal share (25 percent) of the Corps of Engineers Acequia Program. Under annual supplemental agreements to the 1992 Local Cooperation Agreement with the Corps, the state's share has ranged between $300,000 and $500,000 each year since 1987. Other contracts entered into with the Natural Resources Conservation Service are for watershed planning and agricultural conservation demonstration projects.

For protection of irrigated lands, irrigation facilities and the contracts, loans have been made to the Doña Ana County flood commissioner and the Chaves County flood commissioner for this purpose. Major appropriations in past years made from the Irrigation Works Construction Fund by the legislature include the rehabilitation of the Santa Cruz Dam, Costilla Dam, Ponderosa Dam and Storie Dam.

The Irrigation Works Construction Fund has been a source of funding for the Pecos River Lease and Purchase Program of water rights and was a funding source for the Pecos water settlement with Texas in the amount of $14 million. The fund has been the source of money for a continued program to reduce nonbeneficial use of water in the Pecos River Basin, a program carried out by the Bureau of Reclamation.

The statement I just read concerns the Interstate Stream Commission part of the fund. I would like to point out that the Commission has appointed an agricultural conservation task force which has worked for nearly one year, and is co-chaired by Hal Engle and Paulina Salopek.

In August, a water conservation conference took place at New Mexico State University and one of the papers presented was "Economic Incentives for Agriculture Can Promote Water Conservation" by Drs. Frank Ward and J. Phillip King (paper follows this panel discussion). I think this document has the potential to address some of Robert Faubion's concerns.

This leads me to the other main item I wanted to discuss today. I am a president of a federation of acequia commissioners that represents 64 acequias. In conjunction with the Rio Chama Federation, which is a major water adjudication, we probably represent about 100 different acequias. The water adjudications brought to the surface some of the problems the acequias have been facing. For example, 1969 hydrographic surveys show fallow lands where now we have a lot of housing being built over formerly irrigated lands. This is a major concern. We recently initiated a geographic information system (GIS) program for the acequia system. We want to incorporate those hydrographic surveys into the GIS. We also are cooperating with counties, municipalities, and other entities to obtain additional information for the system. I think the other information that has been described here fits within the geographic information system plan that we are looking at.

We also are looking at water banking. The Middle Rio Grande Conservancy District has a water banking plan with about six features and I think it fits our system. The plan has not received approval from the State Engineer Office. I am pleased to see that House Bill 139 during the last legislative session dealt with the forfeiture issue. We have been concerned with that issue because the 1959 statute provided that you could "use it or lose it." In 1969 *the statute* provided that the state engineer had to give a one-year advance notice before you lost your water right, thus giving an owner the opportunity to put their water to use. However, I think the forfeiture statute this year deals with a conservation program that allows conservancy districts, irrigation districts and acequias to enter into conservation programs based on state engineer approved conservation guidelines. We have had a proposal before the state engineer on forfeiture for a couple of years; however, with the passage and signing of House Bill 139 relating to forfeiture, I think we are getting closer to coming up with a plan the state engineer would approve. The question I think is mostly from the administration end of it—who does it or how does it relate to the state engineer.

Thank you.