Water Currents

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Dear Reader:

Using rainfall more efficiently for dryland crop production is one of several soil and water conservation challenges facing Texans.

According to the Natural Resources Inventory of 1982, 71 percent of our state's cropland - 23.6 million acres - is dry cropland.

At some time during the growing season, nearly all the crops grown on this land would benefit from extra soil moisture.

There are, of course, some proven techniques to increase efficient use of rainfall. Terraces, contour farming, and conservation tillage increase infiltration - at least to some extent - while reducing erosion.

But that's not enough. Today's farmers need more information about alternative methods. They need to know, for example, the effect on soil moisture storage by soil types when cropland is disturbed or plowed with different types of implements. They also need to know how much more moisture would be saved by switching to herbicides to control weeds. Then they need to know how each acre-inch of moisture saved relates to yields of various crops for their locality.

Texas farmers also need additional information about windbreaks and windstrips (narrow rows of perennial grass planted across cropland). They need information on the effect on crop yields, cost benefits, proper width, and the best species to plant.

Similar kinds of information are needed to more fully understand when and how furrow diking can be used to make more efficient use of rainfall and to reduce erosion, as well as effects on crop yields.

On some soils, plow pans greatly restrict moisture penetration. On the Texas High Plains, infiltration studies reveal that some soils with a high bulk density plow pan will absorb only 2.5 inches of moisture in 24 hours. Similar soils without a plow pan will absorb more than three times the amount in the same period. Farmers need easier methods of detecting, correcting, and preventing plow pans.

Information is also needed on how to reduce moisture losses through transpiration and evaporation.

The way to gain this information is through research and with computer models. The information then needs to be disseminated to farmers through demonstrations, tours, and field days sponsored by farm agencies and organizations.

Someday farmers and agricultural workers, using computers, will be able to input soils information for their farms along with alternative treatments including tillage methods, windstrips, windbreaks, furrow diking, and other practices. The computer will then calculate moisture savings, expected reductions in soil loss, projected increases in crop yields, and expected net profits for each alternative.

That will bring a new era in making more efficient use of rainfall on cropland in Texas.

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Storing Soil Moisture

Through the years, Texans have begged cloudless skies for rain, have prayed for rain, and have hired rainmakers to shoot cannons into the sky for rain. They have even hung black snakes in trees for rain. Yet today they still wait for rain.

Texas farmers do have ways, however, to increase the amount of moisture available to their crops. They can cultivate their fields so that the soil welcomes the rainfall and holds it until it is needed by a crop.

Farmers can shape their fields and furrows to reduce water losses from runoff and evaporation. They can reduce the soil compaction caused by heavy equipment and can break up the layers of soil to encourage water movement. They can leave crop litter after harvesting to help hold the rains which fall between growing seasons.

Farmers can take advantage of the available moisture in their fields by planting crops which develop at the times moisture is most likely to be there. They can also select crops which give the most consistent yields even when subjected to periods of moisture stress.

Researchers with The Texas Agricultural Experiment Station (TAES), the state agricultural research agency, have developed many present-day techniques to make the most of Texas' undependable rainfall. These methods often mean the difference between plowing under a scorched crop and marketing a harvest.

TAES scientists express optimism about the potential for further increases in both irrigated and dryland yields due to more efficient use of water. They have found, however, that while efficient water use is extremely important to irrigators, it is absolutely essential for dryland producers.

In many areas of the state, there is not enough precipitation during the growing season to meet a crop's water needs. The dryland producer must prepare his field so that the moisture from pre-season rains is held in the soil profile.

The first priority in increasing soil moisture, according to researchers, is to stop or at least greatly minimize loss of rainfall from runoff. After that, farmers should modify their operations to cut evaporation losses and should select crops and crop management systems best suited for the rainfall patterns in their region.

Researchers with TAES have identified furrow diking and conservation tillage as two of the most promising methods of increasing water use efficiency in dryland crop production. The following are but a few of their current or completed projects to evaluate and improve these two methods for Texas dryland producers.

FURROW DIKING TO REDUCE RUNOFF

Furrow diking can reduce, even eliminate, runoff from cropland. It involves forming mounds of soil across furrows to hold rainwater. Small basins created by the mounds or dikes retain rainwater until it can infiltrate.

The practice of furrow diking has spread rapidly throughout the High Plains and in other areas of the state and is especially popular with dryland producers. TAES researchers estimate that more than three million acres on the High Plains are now furrow diked at some time during the year.

They predict that in years with average or better rainfall, furrow diking could increase crop yields in the High Plains by as much as $87 million.

Furrow diking is more economical than other common methods of holding water such as terracing, contour farming, and leveling. Terraces and various types of field leveling involve extensive modifications to the land, use of heavy equipment, and expensive maintenance procedures. Furrow diking, in contrast, involves moving very small amounts of earth and requires little additional equipment or effort by the farmer.

The equipment needed for furrow diking is relatively inexpensive and can be purchased from several farm equipment manufacturers. It is also simple enough for farmers to build with materials found in most farm machinery shops. According to TAES research, the equipment needed to form dikes can pay for itself in just one season with the increased yields from only 75 acres of cotton.

Furrow diking equipment was designed and tested in the mid 1970s by Bill Lyle, an agricultural engineer stationed at the TAES research center in Lubbock. A paddle wheel type implement attaches behind most implements, so forming the dikes does not require an extra trip across the field. Lyle also designed a plow-out attachment to be placed in front of tractor tires to break down the dikes.

Lyle is quick to point out that the idea of mechanically forming dikes was tried as early as the 1930s. The basins were formed back then during the fallow period partly because dikes interfered with the other cultivation practices and because they gave the tractor drivers a very rough ride.

Dikes need to be in during the growing season, says Lyle, because most runoff occurs during the spring and summer months when the crop is in the field. Sixty to seventy percent of all rainfall comes in the Lubbock area during the cotton growing season.

Lyle and other TAES engineers have compared fields with and without furrow diking and have found that furrow diking can mean a 25 percent increase in cotton yields and as much as a 30 percent increase in grain sorghum yields. Evaluations of furrow diking have been under way every year since 1975 at the TAES research centers in Lubbock and in Halfway.

Researchers in other areas of the state are also assessing the value of furrow diking with their particular climates, soils, crops, and cultivation techniques.

G. B. Thompson, director of the TAES research center in Amarillo reports acceptance of furrow diking by both irrigation and dryland crop production.

Good reasons for this widespread adoption of furrow diking was demonstrated in the TAES research fields at Etter, north of Amarillo. Researchers measured 3.47 inches of rainfall held in furrow-diked fields while that amount ran off the fields without furrow dikes. This moisture meant twice as much grain sorghum harvested in 1981 in the furrow diked fields compared to the fields without dikes.

Researchers at Bushland and Etter, research sites associated with the Amarillo research center, report that in five crop seasons furrow diking increased sorghum yields 18 percent. Reggie Jones, a scientist with the Agricultural Research Service, U.S. Department of Agriculture, and Dan Undersander, a TAES agronomist, work on the joint effort. They have tested furrow dikes in alternate furrows of dryland fields and on the lower nonirrigated portions of limited irrigation fields.

During the five years, the portions of the fields with diking produced consistently higher yields and held an average of one and one-half inches more storm runoff. Jones and Undersander report that during one 24-hour period, the diked furrows held a six-inch rain without losing any of the moisture to runoff.

Researchers working in the Rolling Plains of Texas south and west of Wichita Falls also report dramatic increases in sorghum yields between diked and nondiked test areas.

Soil scientist Cleveland Gerard says that runoff is a serious problem on many Rolling Plains soils. Soils in the region characteristically have poor structural stability which means significant loss of water and soil to runoff even during moderate rainfall. This loss in runoff not only severely limits crop yields, but also wastes water, soil, and soil nutrients according to Gerard.

Gerard's research has pointed to the importance of diking in order to catch water during the area's historically high rainfall months of April, May, June, September, and October. To be most effective in the Rolling Plains, dikes should be formed before planting, certainly before April 1. He points out that dikes can be plowed out during early cultivation and fertilization, but should be replaced to catch rainfall during the growing season, especially the early fall months.

His research has shown that the additional soil moisture from furrow diking will not only increase cotton yields per acre, but it will also improve fiber quality and increase profits for dryland cotton growers.

According to Earl Gilmore, director of the TAES Chillicothe-Vernon research center, just one inch of moisture stored in a field means an additional 30 pounds of lint. And at Bushland, near Amarillo, TAES research has shown that one inch of water stored in the soil can mean an additional 350 pounds per acre of grain sorghum or an additional two and one-half bushels of wheat.

Scientists at the TAES research center in Temple have found that an average of three inches of valuable rainfall runs off Central Texas fields between March and June of each year. Most of this loss occurs in April and May. They used rainfall and runoff records collected on two research watersheds since 1947 to determine that furrow diking could save enough moisture to make it a good management technique in the Blackland fields around Temple.

Other sites where furrow diking is under evaluation by TAES researchers are at the Uvalde research center where soil scientist Jim Mulkey has an ongoing project and in a new project at the Corpus Christi center. There project director and soil chemist, John Matocha, set up test sites in 1984 to study furrow diking in corn fields in Bee County and in a grain sorghum field in Jim Wells County.

A new project designed by Jerry Arkin and John Nieber will use computer modeling to assess the effects of furrow diking. Arkin is the TAES research director at the Blacklands Research Center at Temple; Nieber is with the Department of Agricultural Engineering on the Texas A&M University (TAMU) campus. Their research should provide useful ways to determine the effects of furrow diking in any combination of soils, climates, and crops.

Another researcher using computer modeling to compare conventional furrows with diked furrows is Kirk Brown, a soil scientist at Texas A&M. He compares diked furrows with those diked in alternate rows. Brown's study also includes how soil moisture stored before planting affects crop yield, how plant canopy affects evapotranspiration, and from what part of the soil profile plants extract water from the soil.

CONSERVATION TILLAGE TO HOLD MOISTURE

A good way to increase soil moisture storage is to reduce tillage operations, say TAES researchers. Reduced tillage, or conservation tillage, is the practice of leaving some or all of the crop residue on the field surface after harvest. The crop residue reduces runoff and erosion losses and adds organic matter and nutrients to the soil.

TAES researchers David Bordovsky and Cleveland Gerard have conducted a five-year study at the research centers in Chillicothe-Vernon and Munday to determine the effects of reducing tillage practices on field crops in the Rolling Plains. They concentrated especially on the changes in chemical and physical properties of the soil and also looked at the effects of conservation tillage on yields of wheat and sorghum.

The researchers grew sorghum and wheat crops on research plots. They cultivated half of the plots with tillage operations commonly used by farmers on the Rolling Plains, while reducing operations on the other plots. Between harvest and planting sorghum, for instance, the conventionally tilled plots required five operations (shredding, two diskings, listing, and cultivating) compared to one operation (herbicide application) on the conservation tilled plots.

Gerard and Bordovsky found that conservation tillage increased soil moisture storage by reducing runoff and evaporation. Timely rainfall during the growing season, however, often negated the moisture storage differences between conservation and conventional tillage practices.

They warn that changing tillage practices can change a soil's structural properties due to slow drying and moisture conditions. Slow drying due to residue in conservation tillage systems can increase natural soil compaction and reduce soil permeability. Conservation tillage, according to Bordovsky and Gerard, requires increased use of chemicals to control weeds and insects.

Conservation tillage is also a major research focus at the research center in Corpus Christi. John Matocha has directed research there since 1977 to determine the effects of reduced tillage operations on crop yields and soil moisture. He has found that, in dry years, conservation tillage in the Coastal Bend area can mean higher yields compared to conventional tillage. In average or high rainfall years, he has found no significant difference in yields between the two methods.

Matocha figures Coastal Bend farmers can save about $15 per acre by reducing tillage operations. He points out that fewer trips across the field can mean not only savings in fuel and operator hours but also less strain on equipment and maybe even less equipment. Matocha points out, however, that as more chemicals are used to control weeds and insects, and as costs for these chemicals increase, the savings for reduced tillage will not be as great.

Yields of the three major cash crops in the Coastal Bend area - grain sorghum, corn, and cotton - are all highly related to adequate soil moisture throughout the growing season. One-third of the annual rainfall traditionally comes after crop harvest in the fall. Matocha believes that leaving crop residues on the field surface is an effective way of storing the fall rain - often intense, hurricane-related rain - in the soil profile for the next planting season.

Researchers at the Blacklands Research Center near Temple have evaluated the advantages and disadvantages of conservation tillage on the poorly drained soils common in their area. Tom Gerik, with TAES, worked with John Morrison, a scientist with the Agricultural Research Service, U.S. Department of Agriculture, to compare yields, costs, and soil moisture storage of conventional and conservation tillage using field research and economic modeling.

Gerik also evaluated the effects of tillage methods on soil temperatures in field plots planted with grain sorghum and then winter wheat.

After monitoring research plots for two crop years, Gerik concluded that reducing tillage operations did not significantly change the grain sorghum yields, the soil moisture, nor the soil temperature in the poorly drained Blackland soils.

In another study, Gerik found that the practice of maintaining the same wheel tracks each year - called controlled traffic - does not reduce grain yield except in exceptionally dry years. In average or better rainfall years, wheat in rows adjacent to the compacted traffic zones compensates by producing more grains than wheat in other parts of the field.

Scientists with TAES are optimistic about the potential for increasing yields under dryland conditions. Their studies have shown that in every area where dryland crops are grown, the primary limiting factor is soil moisture. The first priority in stabilizing dryland production, according to the researchers, is to stop or at least greatly reduce the loss of moisture from fields.

Through this research, Texas farmers can - and must - learn to hold the moisture in their fields. They must stop it from escaping downstream, evaporating in the air, or percolating below the crop root zone. In other words, they must learn to make the most of whatever moisture comes their way.

Farming, a Risky Business

Dryland farming in Texas is a risky business. It requires daring, cunning, patience, and faith. Most of all it requires faith that rains will come. If not this year, then surely next.

Dryland farmers today make some of their decisions based upon results from researchers with The Texas Agricultural Experiment Station (TAES). They learn from the researchers how to better their chances of producing crops in less than ideal moisture conditions.

And produce they do! The more than 20 million dryland acres totally dependent upon Texas rainfall produce one-fourth of all the grain sorghum grown in the U.S. and fifteen percent of all U.S. cotton annually. Other major dryland crops in the state include wheat, corn, and peanuts.

Agricultural economists predict that as costs for pumping irrigation water continue to soar and as water supplies for irrigation continue to decline, more and more producers will turn to dryland production. And they may find that they can "make ends meet" more easily with dryland farming than with irrigated crops. They will find that dryland farming generally requires far less equipment, energy, labor, seed, fertilizer, and chemicals than irrigated production.

But dependence on a resource as variable as Texas rainfall is still, at best, an unpredictable business.

Jerry Arkin and Bill Dugas, two TAES scientists stationed at the Blacklands Research Center, have developed methods to better assess the risks associated with dryland farming. Arkin is director of TAES research at the research facility at Temple; Dugas is a TAES agricultural meteorologist there.

They say that even though the risks for dryland producers will always be high, TAES research work with computer crop models using historical weather data can help dryland farmers make reasonable assessments of these risks.

Arkin and Dugas combine rainfall and other meteorological data such as temperature and humidity with models that simulate crop growth. They use this information to predict how well a crop will produce under certain conditions or to recommend specific management strategies.

With information collected from years of field research, they can simulate daily growth and development of plants without actually planting and waiting for the development. They can also simulate plant growth in combination with rainfall patterns, cultivation strategies, and planting dates without having to wait for the appropriate weather conditions to see how the crop reacts.

Modeling can help a farmer use existing soil moisture and rainfall probabilities to assess the potential for the next crop. With this information he can determine the probability of producing a paying crop on the land and whether it would be advisable to leave the field fallow during the next growing season.

What and when to plant are not the only types of advice available from the crop modeling efforts of the TAES researchers at Temple. Arkin and Dugas have evaluated other management decisions to help Texas farmers better manage the limited moisture available to them.

Arkin, for instance, evaluated row spacing by using computer modeling based on the known relationships between soil, atmosphere, and plant development. He concluded that dryland producers could increase sorghum production by 10 to 15 percent by planting sorghum in narrow rows rather than conventionally spaced rows. He says that narrow rows are now common not only in Texas dryland areas, but in other parts of the world as well.

The researchers also use the models which simulate crops at different stages of development to evaluate drought impact on Texas crops, cropping systems, and yield potential.

Even though the methods Arkin and Dugas use are sophisticated, they produce up-to-the-minute, practical recommendations for producers. By combining models which take into account crop growth and development and weather data, the researchers can supply specific, current information for site-specific decision making.

They even have programs available that can in the future be used by farmers on their home computers. These programs, based on the crop growth models used by Arkin and Dugas, would allow a farmer to plug in specific information about the soil, soil moisture, and crop in a particular field. The program would then help him to assess yield potential and to decide on the best management practices for his particular situation.

Crop growth models give a dryland farmer more up-to-date tools for decision making; but no matter how sophisticated his planning tools or how enlightened his decisions, he can't grow a crop without soil moisture. Because he depends upon rainfall for soil moisture, his will remain a risky business.

Ripples & Waves

C. J. Gerard and L. E. Clark, Texas Agricultural Experiment Station scientists, conduct research in fields outside Chillicothe and Vernon to determine if dryland sorghum can be grown as an alternative to cotton and wheat. Their results so far indicate that if properly planted and cultivated, dryland sorghum is a viable economic crop in the Rolling Plains.

Clark's research has shown that dryland or irrigated sorghum planted in late June or early July in the Northern Rolling Plains yields more than sorghum planted earlier in the year. He has also studied planting sorghum in patterns which skip one or two rows between planted rows.

Skip-row patterns of planting were also evaluated in a five-year project at the TAES research center in Yoakum. Crop physiologist Mike Schubert studied dryland peanuts planted in every row, peanuts planted with two rows planted and one row left fallow, and with two rows planted and two rows left fallow. He concluded that in very dry years, peanuts produced best when planted in a two rows planted, two rows fallow pattern. In years with normal rainfall, the two skip-row patterns performed equally, with both producing more peanuts per planted acre than the solid planting pattern. Yields ranged from more than 3,000 pounds per acre in 1979 to less than 500 pounds per acre in 1982.

He also found that late maturing soybeans planted in mid July in the fallow rows of two rows planted and two rows fallow between peanuts do not lower the peanut yield significantly.

James Mulkey, a TAES scientist at the Uvalde research center, studies different classes of wheat to determine the most efficient ways to use irrigation water.

He found that the time wheat is sown affects its water use efficiency. Fall-sown wheat required 20 inches of water to produce 50 bushels per acre while wheat sown in January needed only 17.5 inches of water to produce 50 bushels of wheat.

Mulkey discovered an even greater difference in the time interval the water was needed. The interval in which the water was used was much shorter in the late-sown wheat than the crop sown in the fall.

Farmers in the Coastal Bend Region can improve cotton lint yields by rotating cotton with grain sorghum, according to John Matocha's research at the TAES research center in Corpus Christi. Plant stress due to limited moisture, says Matocha, is the principal factor limiting cotton production in the Coastal Bend Region. He found that a cotton crop following another cotton crop became moisture stressed earlier than did a cotton crop following a grain sorghum crop.

Matocha also concluded that soil moisture differences due to crop rotations were greatest in seasons with below normal rainfall.