There are numerous methods of obtaining additional water, ranging from paving the desert to sea water conversion. To date, all of these methods have been too expensive for irrigation agriculture. Experiments conducted this Spring at The University of Arizona indicate that treatment of watersheds with common table salt may provide additional water at a price low enough for irrigation.

USING SALT TO INCREASE IRRIGATION WATER

By C. Brent Cluff and Gordon R. Dutt

Although most reservoirs in Arizona are nearly full now, this has not been the case for the last 25 years.

Because of the important need for more water, considerable research has been done in Arizona in vegetative manipulation to reduce evapotranspiration loss and thus increase streamflow. It has been estimated that Arizona harvests only 4 to 5 percent of its annual precipitation for beneficial use. Most of the precipitation that falls on the state is returned directly to the atmosphere in the form of evaporation.

"Pave" to Save

In addition to modifying the vegetation density to increase streamflow, considerable research has been done in developing materials to "pave" watersheds. Although these methods are relatively expensive (in excess of $300 per acre) they are designed to catch nearly 100 percent of the precipitation. Currently this type of "paved watershed" is being used primarily as a source of stock water supply.

Soil scientists have long known that sodium greatly affects the rate of movement of water into and through soils. Indeed, the criteria for determining the suitability of water for irrigation, and analyses of irrigated soils, consider the sodium content as one of the principal factors. One of the main reasons for this interest is that in soils with a high sodium content, the rate of intake of water is so slow that the depth of penetration is limited.

Thus, sodium salts are considered detrimental to irrigated soils. In watershed areas, however, this may not be the case. Sodium salts may well give us a practical way to increase runoff from watersheds, and to develop areas which are now relatively non-beneficial.

Salt, Clay Work Together

If water is to run off, rather than infiltrate into the soil, then the intake rate of water through the surface must be lowered. An effective way to do this is by increasing the exchangeable sodium concentration in the soil. This can be accomplished by applying common table salt, sodium chloride, to the surface. When it rains, the salt on the surface will go into solution and interact with the clays that are present.

When the salt content of water is high, there is a high initial infiltration rate. Thus, the salt in solution moves into the soil. At this point the sodium adsorbed on the clays has been greatly increased. Now, as additional salt-free rain water enters the soil, the sodium adsorbed on the clays remain, but the concentration of the salts in the soil solution becomes low. The clays become highly dispersed and block the water-conducting channels present in the soil. Therefore, the infiltration rate is drastically cut. In that way less water enters the soil and runoff is increased.

After the rainfall, evapotranspiration processes produce moisture gradients which move the water and salt in the soil towards the surface. Therefore, a cycle has been completed. This cycle would be repeated following additional rainfall.

To Test a Theory

In order to test the sodium salt treatment in Arizona, 10 pans were filled with three different soil types and subjected to normal rainfall. Results of the first storm following treatment are shown pictorially in the photo at bottom of this page. Pans 1, 3 and 5 were treated to attain a 15 percent exchangeable sodium percentage in the surface inch of soil. This is the threshold concentration for classification of alkali soils. The

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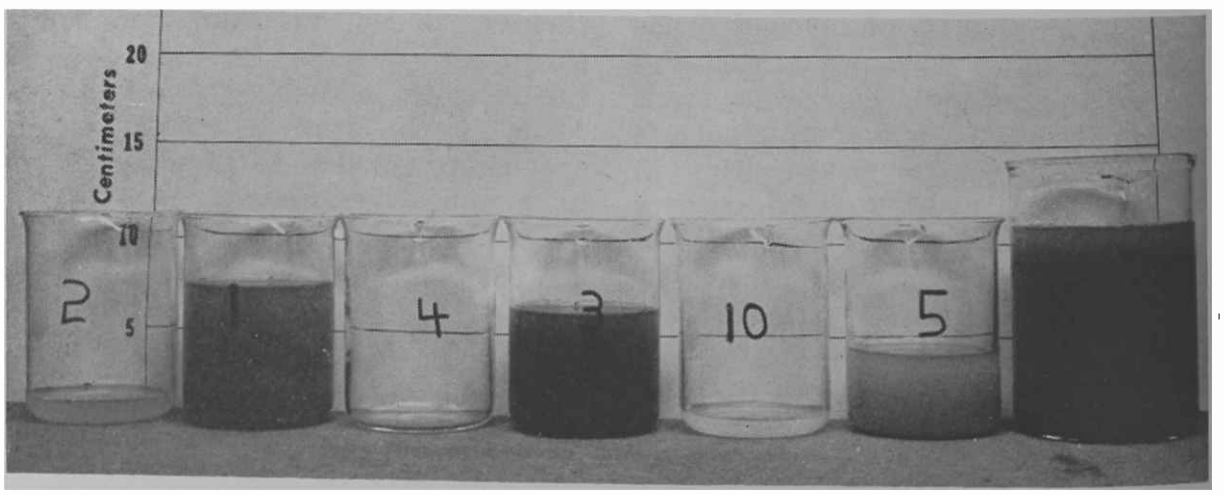
WATER YIELD from pans after a 0.39 inch winter rainfall. Runoff in pans 2, 4 and 10 — almost none at all — came from the untreated soils. Pans 1, 3, 5 and 8 (numbers obscured because of turgidity of water, but still indicating substantial quantities) came from the treated soils.



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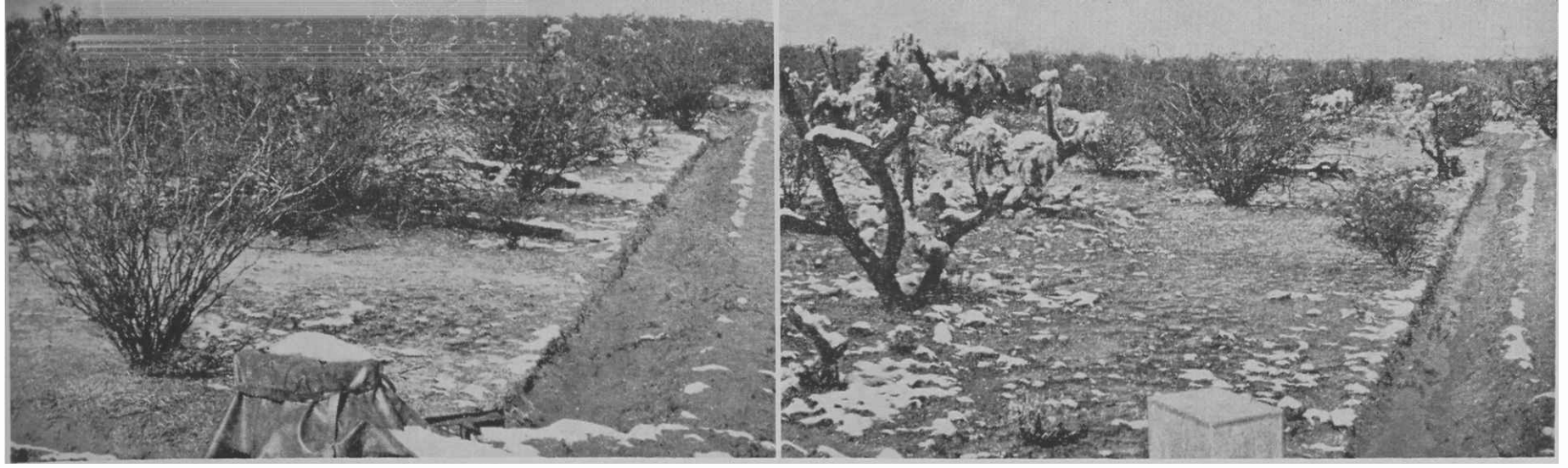
The authors gratefully acknowledge the help and cooperation received from Dr. W. D. Kemper of Colorado State University, who was the first to demonstrate on small pans that the characteristic reduction of infiltration due to sodium salts might be helpful in increasing runoff.



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treatment rate in Pan 8 was doubled to achieve a higher sodium percentage. Water yields ranged from none on the untreated soil in Pan 4 to 49 percent water yield from the treated soil in Pan 8.

Following these significant results, two one-acre plots on the Atterbury Experimental Watershed, located on the valley floor east of Tucson, were selected. A border was placed around each of these plots which confined the runoff so that it could be measured. Otherwise the plots were undisturbed. One plot was used as a control, while the other acre plot was treated with sodium chloride. Treatment was made in January, 1966 with a cyclone seeder, as shown at the right.

Following treatment, a total of 2.90 inches of precipitation was received in seven storms, including 0.40″ which occurred in the form of snow. The photos at the top of this page show visual evidence of the effect of the sodium treatment in reducing the infiltration rate. These pictures were taken when the snow was melting. Note that there was no visible surface water from the melting snow on the control plot, but there was substantial surface water on the treated plot. Of the 2.90 inches of precipitation, 10.3 percent has been measured as runoff from the treated plot compared to less than 0.4 percent water on the control. *The sodium chloride treatment increased runoff about 25 times.*

The quality of water coming off the treated plot is remarkably good. As indicated earlier, the added salt moves into the soil and is not present in the runoff water. For all runoff trials, water from the treated plot contained less than 200 parts per million dissolved salts. This may be compared with the salt content of the lower Colorado River which contains from 800 to 1000 ppm.

Cost Seems Moderate

As far as economics are concerned, the cost of a treatment of large areas with sodium chloride, including aerial application, has been estimated to range from $6 to $12 per acre, depending on the amount of salt required. For a given watershed, the effective life of this treatment and the water yield would vary according to the soil, rate of salt applied and the amount and rate of precipitation.

For the three soils tested, it appears that the initial treatment should last several years. Subsequent treatments would be at a lower rate. In an area with an 11-inch annual rainfall, it appears that the treatment would increase water yield by 1 to 2 inches per year. This compares with a 1.8 inch annual water yield from the Salt River Watershed, which has an average annual precipitation of 18 inches.

Right now there are too many unknown variables to make a prediction of the exact cost of producing additional irrigation water using sodium chloride. However, preliminary results and the theory involved indicate that it should be possible to stay within the economic limitations of irrigated agriculture, particularly in areas where the rainfall exceeds 12 inches per year.

Before treating large areas to provide irrigation water, additional research must determine the best treatment rate for various conditions. Sufficient salt should be applied to increase runoff without destroying the perennial vegetation. Steep slopes would be treated with less salt to avoid excessive erosion.

Meanwhile, we have sufficient data on smaller areas to recommend sodium treatment to provide water for livestock.

ABOVE, LEFT, untreated plot during the snow melt. Note little snow on the surface and no water in the ditch. At right, the treated plot, with snow and surface water, as well as considerable water in the ditch.

USING A PLAIN litle cyclone seeder, such as is sometimes used for spreading grass seed, C. Brent Cluff "seeds" plain table salt on the test plot.

Agua Fria Is Winner In State FFA Contests

Agua Fria Union High School at Avondale won the sweepstakes plaque in statewide competition during the Future Farmers of America Field Day March 19 at The University of Arizona.

To win, Agua Fria teams racked up the highest total score in a minimum of six contests testing their agricultural skills.

Some 850 FFA boys took part in the field day on The U of A campus and at nearby U of A experimental farms.

Contests included poultry judging, agricultural engineering, livestock, dairy cattle, meats, soils, agricultural economics, agronomy, horticulture, range management, and entomology.

Douglas High School won second place. Willcox High School, Washington High School at Glendale, Tempe Union High School, and Amphitheater High School in Tucson won honorable mention for winning third, fourth, fifth, and sixth places, respectively.