On Black Mesa Spoil Heaps, Harvested Water Becomes the Key to a Harvest of Vegetables

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A five-acre garden grew this summer on coal mine spoil on the barren Black Mesa because the earth that had been displaced by strip mining was reshaped and treated to collect rainwater. Only about 10 inches of precipitation a year falls on this part of northeast Arizona, so water is the limiting factor in the land's productivity. The rows of beets, squash, potatoes, corn and other vegetables tended by Navajo high school students this year got extra water in the runoff from 12 acres of treated mine-spoil heaps.

Strip-mine reclamation usually means returning the spoil heaps to the area's original contour, replacing the topsoil, mulching, and planting new vegetation. That works well in many parts of the country, but not in the dry West. The area being mined on Black Mesa is marginal rangeland supporting only about one cow or five sheep per square mile. Frozen, windy winters and hot, windy summers at this 7,000-foot elevation compound the problems of aridity. The usual reclamation process here yields land with very low productivity at costs which may hit $14,000 to $28,000 per acre.

The University of Arizona, cooperating with the Peabody Coal Company and funded by the U.S. Bureau of Mines, is examining water-harvesting as a more productive sort of reclamation. Dr. John L. Thames, watershed management professor for the UA College of Agriculture, and Dr. C. Brent Cluff, hydrologist for the UA Water Resources Research Center, head the project, the first of its kind in the nation. A feasibility study finished in 1977 says that water-harvesting can increase the economic and social benefits from reclaimed strip mines in the dry West.

Randolph Laughter, Eric Schwennesen and Oliver Whitehair (left to right) display one August day's harvest of turnips, squash, tomatoes, onions, beans and beets grown at the Black Mesa Water Harvesting Project last summer.

Reclamation as Opportunity

Peabody is mining about 200 acres of coal on the Black Mesa each year to fuel the Mojave and Page power plants. The coal seams underlie 60 to 80 feet of soil and rock. This overburden is removed from a long strip about 100 feet wide and piled up alongside. Once the coal from that strip is dug out, the adjacent strip is laid bare, with its overburden moved onto the area of the first strip. A series of ridges 60 to 100 feet tall results as the strip mining continues. By the late 1980s, attempts will have been made to reclaim 1,400 acres of these mine-spoil heaps on the mesa.

In the newly planted orchard, project crew members spread gravel by hand over the catchment surface between rows of seedlings.

The water-harvesting approach views the need to move large amounts of land as an opportunity to maximize benefits by reshaping the land, instead of as a problem of returning it as close as possible to its former shape.

The UA project blends the ancient practice of water-harvesting with the modern technology of computer modeling and mapping.

Nearly 4,000 years ago, farmers in Israel's Negev Desert harvested rainwater for their wheat by clearing and smoothing hillsides and channeling the runoff onto their fields. American Indians around Mesa Verde, Colorado were using simple water-harvesting methods for irrigation 400 to 700 years ago. Australian farmers have been refining water-harvesting technology since the 1920s. Recent interest in this way of exploiting rainfall in Arizona is evidenced in the Page Ranch project described in the Fall 1979 *Progressive Agriculture in Arizona* and in the 4-H camp project described in this issue.

For the Black Mesa project, computer analysis of surface slope and texture, absorption rates of the soil, precipitation records, erosion rates and other factors can determine ahead of time what land contours will give the maximum runoff with minimum erosion. Computer modeling can predict how large a catchment surface is necessary to irrigate each acre of agriculture.

Evaporation Loss

Thames and Cluff began gathering data for computer modeling in 1973. Five years later, work started on the catchment areas, the evaporation-efficient storage ponds, and the garden and orchard.

With large mining equipment, Peabody crews scooped out three storage ponds at different elevations. The three will hold up to two million gallons. Each pond is 10 to 15 feet deep to minimize evaporation. For added defense against the area's dry winds, a pump can pipe water from the lower ponds to the top one, reducing the surface area exposed. Cluff plans to install a floating solar collector on one pond, both as a cover to reduce evaporation and as an energy source for the pump. A prototype of the floating collector is working well on the UA campus. It rotates in the water to track the sun's daily course.

After digging the ponds, the crews shaped the spoil piles into catchment slopes and a level field. The water-collecting area was treated with about 500 pounds-per-acre of salt and compacted. The salt keeps the slopes plant-free and helps harden the surface. Then, fiberglass gauze was unrolled over the area and sprayed with hot asphalt. A final topping of rock chips protects the asphalt from the sun.

Crew member Robert Curlyhair (right) and UA graduate student Ken Vogler help with treatment of the catchment slope to increase runoff. White fiberglass gauze was unrolled from the back of the truck, then sprayed with hot asphalt.

This full treatment gives a surface that collects 90 to 95 percent of the water that hits it. Channels carry the runoff either directly to the field irrigation ditches or into one of the ponds. The irrigation ditches also empty into a pond so the water can be reused.

At the site, Research Associate Matts Myrhman manages the UA project. Walter Begay of Peabody's reclamation group has coordinated the coal company's involvement, which included the extensive shaping and grading work and the use of equipment.

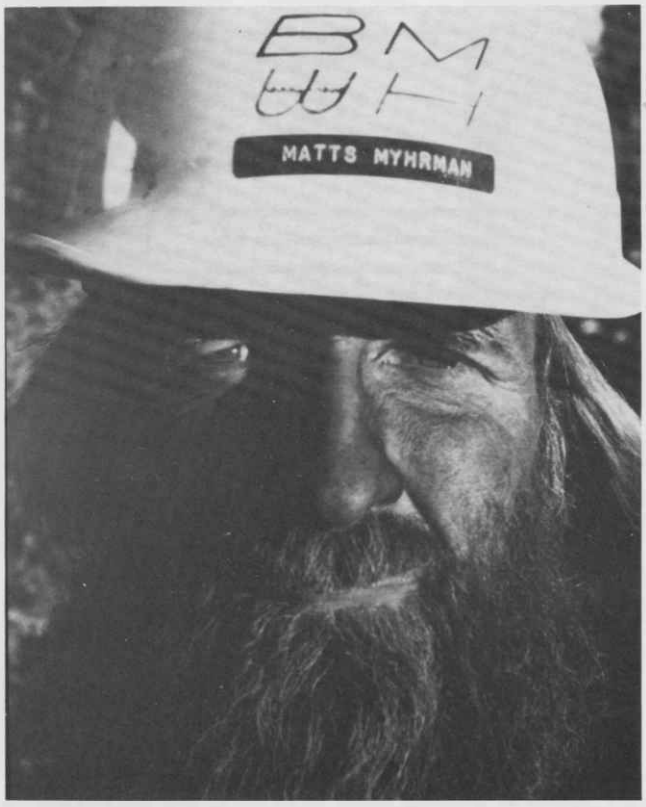
Early last spring, UA Extension Agent Eric Schwennesen of Tuba City planted 80 trees in a one-acre orchard in the irrigated area. The trees include several apple varieties, peaches, apricots and nuts.

Vegetable Garden

Agriculture students from Monument Valley High School in Kayenta planted many types of vegetables in the five-acre field. They tended the garden through harvest, supervised by their teacher, Oliver Whitehair, and by Myrhman.

During the summer, underground settling of spoil material cracked two of the storage ponds, draining their contents. Nevertheless, water collected from the still-unfinished catchment surfaces was adequate for the experimental garden.

The project aimed for experience rather than maximum production this year. Thus, a greater variety of vegetables was grown than is planned for future years.



A layer of dust disguises project manager Matts Myhrman after a day of bulldozing.

Squash, beets, onions, potatoes and native corn did very well. Tomatoes, commercial corn, beans and peas did not. All of the orchard trees looked well by mid-autumn, and the apple varieties seemed to be thriving.

Thames is particularly encouraged because many of these plant varieties have not been grown before at this elevation on Black Mesa, and because the crops grew in raw mine spoil, which is greatly inferior to most agricultural soils. Also, this was one of the driest seasons on record for the area. Only one rainfall greater than 0.14 inch fell during the growing season. That one was less than half an inch. Evaporation rates were intense, high enough to take nearly five feet of water out of a Weather Bureau evaporation pan during the short growing season.

Whitehair and three of his vocational agriculture students tend the channels as the garden's first irrigation is piped from a storage pond in May 1979.

The cracked ponds have been repaired, and catchment surfacing is due for completion next season. Gardening will focus on root crops, squash and corn in 1980. A local Navajo farmer has agreed to supply seed from native corn which has produced well in his own garden.

Meanwhile, Thames, Cluff and Ron Sauer of Pacific Northwest Laboratories have begun another project on 10 acres of spoil heaps nearby. They are studying ways to shape the heaps both to reduce regrading costs and to harvest water.

The collected water irrigates long, narrow plots of range plants in the valleys between the ridges of spoil. The slopes are shaped to minimize erosion. For comparison of surface treatments, one section is untreated, another only compacted, a third both compacted and salted, and a fourth is seeded and fertilized. The project aims to develop an economical mine-reclamation system that yields productive grazing land.