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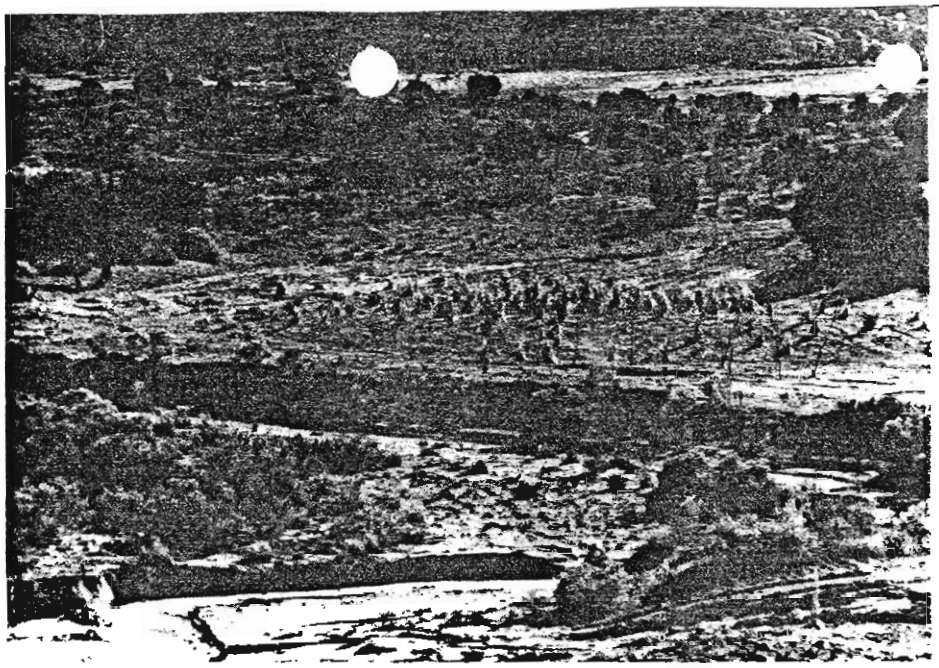

Hopi field located on a stream terrace adjacent to a drainage that may flood during a major storm.

Traditional Hopi agricultural methods

By Deborah J. Prevost, Robert J. Ahrens, and David M. Kriz

MANY soils in the arid and semiarid U.S. Southwest are poorly suited to cultivation unless irrigated. Severe climate and lack of supplemental water generally prevent profitable crop production on these soils. But in some instances these limitations have been overcome by unusually intensive management practices.

Agriculture on the Hopi Indian Reservation in northeastern Arizona exemplifies this type of management. Soils that the Hopi farm are in classes VI and VII and subclasses e and c of the U.S. Department of Agriculture's land capability classification system. Soils in classes VI and VII generally are not suited to crop production unless unusually intensive management is applied or major earthmoving or other costly reclamation work is carried out (*8*). Soils in subclass e are subject to erosion unless close-growing plant cover is maintained. For soils in subclass c, the main limitation is climate that is too dry or too cold.

A harsh land

Despite the harsh climatic conditions and low precipitation, the Hopi people have developed a system of agriculture that has sustained them for hundreds of years.

The Hopi inhabit a semiarid region in the south central portion of the Colorado Plateau. This area was settled by ancestral pueblo-agricultural tribes during the first millenium A.D. (*7*). The Hopi and their ancestors have produced crops continuously with highly specialized techniques.

Current boundaries of the Hopi Indian Reservation surround the southern escarpment of Black Mesa. The northern part of the reservation consists of high, steep-sided mesas and plateaus separated by wide valleys and deeply entrenched southwest-flowing ephemeral drainages. The Cretaceous Mancos shale and Mesa Verde group make up the slopes and escarpments of the mesas (*5*) and underlie moderately deep to deep eolian and alluvial deposits on the mesa tops. The contact between these geologic formations forms an aquifer that feeds small springs along the mesa edges (*4*). Elevations in the highlands range from 5,800 to 7,100 feet.

Gently undulating, wide alluvial valleys characterize the southern part of the reservation. Many small intermittent streams drain the adjacent highlands, fanning out on the flats or merging with major washes in the valleys. These streams deposit great quantities of alluvium, which is subsequently reworked by the prevailing southwesterly winds and redeposited in upstream locations (*4*). Eolian deposits of varying thickness blanket most of the region. Elevations in the southern lowlands range from 4,700 to 5,800 feet.

Annual precipitation in this semiarid region ranges from 6 to 9 inches in the southern part of the reservation, where most Hopi fields are located, to 10 to 16 inches in the higher elevations of the northern mesas (*10*). Rainfall varies from year to year. Its seasonal distribution is marked. Summer rains occur from mid-July to mid-September as scattered convectional thunderstorms. These storms can be locally violent, capable of rapidly cutting and filling arroyos.

Snow accumulates most heavily in January and decreases steadily until May. In May and June, the driest months, strong drying winds blow and less than 1 inch of precipitation falls (*6*). Surface water is scarce except for small springs at the mesa edges.

Mean annual temperature is 50° to 55°F. The growing season ranges from 120 days at the higher elevations to 160 days in the lowlands. The last spring frost normally occurs in mid-May, the first killing frost in late September. The low precipitation, lack of surface water, dry winds during the planting season, and marginal growing season severely limit crop production.

Overcoming the limitations

The traditional Hopi farmer overcomes these climatic limitations by carefully selecting field locations, using highly specialized and labor-intensive farming techniques, and planting adapted crops.

Fields are small, 1 to 5 acres, and widely scattered, which helps to control wind erosion. Corn, the principal crop, is planted from mid-April to June.

Many Hopi fields have been farmed for centuries. Farming a field successfully depends upon a field's physiographic position and proximity to water. Generally, fields are located on small alluvial fans at the mouths of intermittent tributary streams, where water spreads out naturally after storms; on low stream terraces adjacent to drainages that flood during major storms; on sand dunes that receive only rainfall and limited underground seepage; and on artificial terraces constructed near springs to use all available water (*4*).

Most fields are on fans and floodplains.

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Floodwater irrigation is common, but floodwater irrigation does not guarantee adequate water for crops every year because of the irregular nature of summer thunderstorms. Sand dune agriculture is not extensive, and farming on spring-fed terraces, which are used for specialty crops and gardens, is also limited.

Soil characteristics also play a vital role in Hopi agriculture. Deep, fertile, arable soils are common in the alluvial and eolian deposits of the valleys. Climate is the main limitation to cultivating these soils.

The class VI and VII soils have special characteristics that the Hopi farmer has learned to use. Hopi fields are generally located on three kinds of soils: soils that are sandy in the upper part and loamy in the lower part, soils that are loamy throughout, and soils that are sandy throughout.

The sandy over loamy soils commonly have 15 to 30 inches of sand over a loamy subsoil. The sandy surface layer permits rapid infiltration of water and acts as a mulch, retaining water in the loamy subsoil for long periods (*6*).

The loamy soils have a sandy clay loam or clay loam surface and subsoil over stratified alluvium. The loamy surface layer is easily worked, and the stratified layer slow water penetration, holding water in the root zone for longer periods.

The sandy soils permit rapid water infiltration, which minimizes surface runoff. Water is held at very low tension and is readily available to plant roots. Small areas of climbing or tailing dunes over the contact of the Mancos shale and Mesa Verde group receive additional moisture through limited local seepage.

Conserving soil and water

Traditional farming methods improve microniches for plants while minimizing adverse environmental effects. The traditional farmer plants his corn by clearing the soil surface with his foot and making a small hole, 6 to 12 inches deep, depending upon soil and moisture conditions, with a digging stick. He loosens the soil a few inches below this depth and drops 10 to 20 kernels into the hole. He returns the soil and packs it by hand (*1*). He staggers the rows and stubble of last year's growth, spacing them according to his estimate of soil moisture, usually 3 to 4 paces.

Conservation practices are inherent in these planting methods. The planting technique is a form of minimum tillage, leaving most of the soil surface intact and less subject to erosion. Hopi corn varieties have an elongated epicotyl adapted to deep planting, which allows the seed to be placed in a zone of soil moisture reserve and protects the germinating seed from frost and wind damage. Deep planting is especially effective in the sandy-over-loamy soils, where the sand mulch increases water retention in the loamy root zone (*4*). Planting many kernels together ensures emergence in spite of cutworms and other predators, while the clustered survivors provide support and shelter from wind for the inner plants. The staggered rotation of planting sites allows the soil to regain fertility, and wide spacing efficiently uses the limited soil moisture.

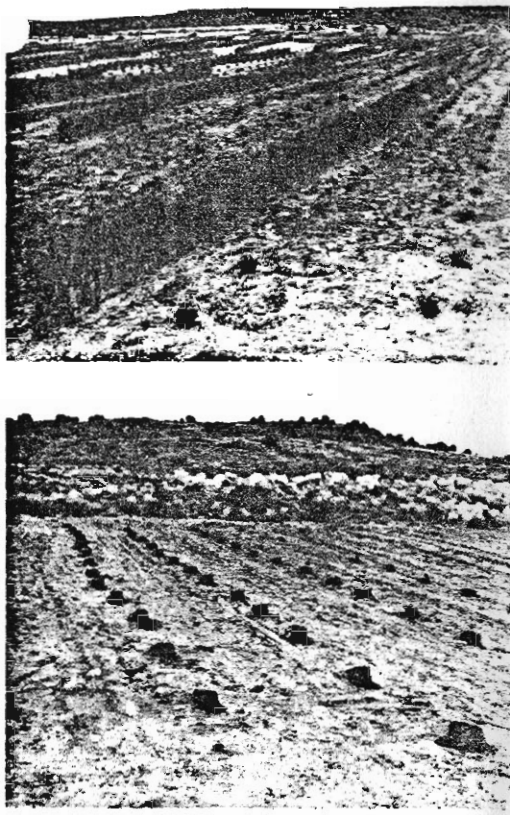
Cultivation techniques also conserve water and soil. Temporary earthen, brush, or rock dams and dikes divert and spread water over fields (*6*). Low ridges are built around seedlings to trap runoff. Shallow, selective hoeing and weeding conserve soil moisture and reduce erosion. Plants are protected from soil blowing with various kinds of windbreaks. Large stones or tin cans are carefully placed around individual plants. Rows of brush, held by stones, are implanted in the soil perpendicular to the wind direction (*4*). Plants are grown on the leeward side of dead stalks, where sand accumulates and blocks the wind. Rows of tamarisks trap sand to form protective ridges at field borders (*6*).

These techniques, highly adapted to the local environment, require a great deal of labor. But they make possible long-term use of soils in an unfavorable climate. Crop yields are low, of course, compared with yields using modern technology in more favorable climates. An acre produces 10 to 15 bushels of corn (*1*).

The changing world

Recent climatic fluctuations and socioeconomic changes are bringing about rapid abandonment of traditional Hopi agriculture. Severe gully erosion and a drier growing season have ended cultivation of many fields. Use of pick-up trucks and tractors has facilitated a shift to larger fields at greater distances from the villages (*2*). Agriculture no longer is the basis of a subsistence economy. People are employed by the tribe, government, and small businesses. Although traditional Hopi agriculture is still practiced in some areas, the total acreage under production has dropped more than 40 percent since 1950 (*3*).

Traditional Hopi agriculture exemplifies a balanced, successfully adapted relationship between people and their unique environment. The farming of class VI and VII land by the Hopis demonstrates that careful management and proper land use make possible sustained crop production under adverse conditions. That ought to remind conservationists today that the depletion of soil and water resources that often accompanies modern farming methods is not an inherent part of agriculture, but a problem that can be solved if environmental limitations are considered in land use plans.



Windbreaks using dead brush placed along rows perpendicular to wind (top). Tin cans help protect young plants from sun and insects (bottom).

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