Twelve Lessons on Water Conservation from Traditional Farmers of the Colorado Plateau

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The cultivation and irrigation of crops adapted to an arid climate began on the Colorado Plateau more than four thousand years ago, as we know from desiccated corn cobs found near Zuni, Black Mesa, and Canyon de Chelly. An unbroken chain of some 160 generations has been engaged in rain-fed and runoff-supplemented production of food, fiber, and dyes with seeds and water-conserving practices adapted to the peculiar soils and microclimates of this region. Many environmental conditions and agricultural technologies have changed, yet some of the same principles and practices of water conservation first utilized by prehistoric farmers have continued relevance today.

Over the last thirty years, I have been blessed with the opportunity to visit dozens of Native American and Hispanic fields and orchards within the semi-arid reaches of the Colorado Plateau. I have seen some Hopi rain-fed fields bear sizeable crops of corn and beans under the care of elderly farmers during severe droughts that have devastated the fields of their neighbors. I have witnessed the tenacity of Navajo orchards planted over a century ago, while most recent introductions of semi-dwarf fruit trees hardly survive a decade. Such experiences have forced me to consider what combination of adapted seeds, traditional knowledge, values, and water management practices have allowed certain traditional farming communities to successfully produce food with far less water than is used by conventional farming.

These practices not only emerged out of Native American communities, but are also derived from Hispanic, Moorish, Arabic, and Persian influences that have diffused into the American Southwest over centuries. The following twelve principles and practices have been used by both ancient and modern native populations to conserve water in the semi-arid landscapes of the Four Corners states.

Lesson One: Plant where rainfall accumulates and where runoff can be stored. Rather than pumping groundwater to irrigate crops, native farmers try to search out places where storm runoff, snowmelt, or artesian spring waters naturally accumulate, and plant on the closest soils that have good moisture-holding capacity. Hopi and O'odham agriculture has been termed *ak-chin* farming, because it locates plantings just below the "mouths of washes" where storm waters naturally spread out and infiltrate the soil. In this manner, traditional farmers harvested not only rainwater but nutrients as well, for runoff carries nitrogen-rich flotsam with it. Only one in fifty acres around Black Mesa may be suitable for such *ak-chin* plantings; the rest is used to shed water that concentrates in the fields placed just below arroyo mouth or mesa slope.

Lesson Two: Divert storm water from washes and spread it out. Where arroyos have suffered too much down-cutting to allow storm waters to spread without the risk of flooding and eroding away the crops, relatively short ditches are constructed so that diversion weirs can direct water away from arroyos into more protected field settings. These fields are often located on the first or second terraces of floodplains where erosive floods occur less frequently. Additional brush weirs are placed in the fields perpendicular to water flows to break their force and allow deposition of moisture, organic matter, and nutrients.

Lesson Three: Store water in low-evaporation cisterns or *alquives*. Where not all the available moisture can be stored in the soil, traditional farmers have sometimes constructed cisterns or earthen tanks in which to store surplus water for future irrigations. In the Southwest, these partially-covered cisterns are sometimes called *alquives,* a Spanish loan word originally derived from the Arabic term *al-jubb.* This water-storage technology may have originally come from the Persians, but made its way into Moorish Andalucía before leap-frogging to arid North America after the Spanish Inquisition. These walk-in cisterns not only store water where little deep infiltration loss can occur, but protect it from evaporation as well.

Lesson Four: Let gravity do the work in moving water. Most water storage tanks or catchments are located above gardens, fields, or orchards, so that these plantings can receive gravity-fed irrigation. Even for hand-irrigation from water ollas, it is easier to carry water downhill than uphill.

Lesson Five: Plant waffle gardens below perennial lakes and springs. Where there are perennial sources of water at springs or lakes, intricate grids of gardens were developed short distances from the high water line. Each grid unit in these “waffle gardens” could be irrigated separately with little transmission loss.

Lesson Six: Place waffle gardens in protected micro-environments. On the slopes of the Hopi mesas, waffle gardens are constructed in micro-environments where they are largely protected from desiccating winds and full solar exposure. This helps reduce evaporation losses from the soil and transpiration losses from the crop canopies, which are otherwise heightened in hot, windy regions due to what is called “the clothesline effect.”

Lesson Seven: Where available, use sand or volcanic gravel as mulch. Contemporary agro-ecological studies at Los Lunas, New Mexico, and on the MNA grounds in Flagstaff confirm that native crops survive longer and yield more produce when they are grown under a mulch of volcanic gravel than when left on an exposed soil surface. Sand and gravel mulches can break up capillary action that otherwise wicks moisture out of the soil.

Lesson Eight: Prune or thin plants during times of drought. By reducing above-ground crop biomass relative to root biomass, traditional farmers give annual crops and fruit trees a better chance of surviving droughts. Hopi often plant twelve seeds per hill and then thin out the weakest of the emerging seedlings, keeping those which rooted earlier and deeper. Fruit trees that are severely top-pruned can endure droughts because their root masses do not have such a large burden of above-ground growth to support.

Lesson Nine: Cluster your plantings. Hopi corn seedlings clustered together in widely spaced hills yield more than those equally distributed in rows, even though the overall densities per acre may be exactly the same. Corn plants clustered in hills provide mutual support for one another by entangling their roots, so that “lodging” or windfall is less likely. They also have higher rates of wind pollination and suffer less desiccation per plant.

Lesson Ten: Grow short-cycle ephemeral crops that require less irrigation. Most desert-adapted seed crops can mature in sixty to eighty days, and therefore require fewer irrigations before reaching maturity than conventional crops do. In this case, they are drought-escapers rather than drought-tolerators, because they can complete their growth during the brief period in the summer when soil moisture is optimal.

Lesson Eleven: Plant deeply, where subsurface moisture persists. The corn and bean varieties typically grown by the Hopi and Navajo can be planted as much as a foot deep in sandy loams, rooting where reserves of soil moisture persist. They are morphologically adapted to have both rapid-growing roots and extended mesocotyls that allow the seedlings to "dig" up through the sand mulch to reach light. Conventional corn and bean seedlings seldom reach up to the surface from such planting depths, bending under the weight of sand accumulated above them. The Hopi carefully prepare a seedbed of fine moist particles of sand where they place their bean and corn to rest.

Lesson Twelve: Intercrop sensitive understory crops beneath the canopies of shade-bearing trees. Heat-sensitive vegetables are often planted in the shade of hardy trees to reduce their direct exposure to the burning rays of the sun and to desiccating winds. These "polycultures" are much more resilient than are sun-exposed monocultures of annual crops. The fruit trees may also benefit from the nitrogen fixed by the roots of understory green beans that have native *Rhizobia* bacteria growing symbiotically on them.

There remain plenty of prevailing risks and occasional calamities that can still plague even the most resource-conserving traditional farmer. There are no foolproof formulas, but native farmers typically require only a fifth of the water utilized by conventional Arizona farmers to grow the same annual crop species. Successful traditional farmers claim that they must be constantly attentive to changing conditions, be willing to work hard whenever rains bless their fields, and humbly pray when droughts have prevailed.

NOTE: For the many lessons that can be learning from traditional farming and ranching among Hopi, Zuni, Navajo, Anglo, and Hispanic communities in the Lower Colorado River watershed, this region has become a candidate for recognition as a Globally Ingenious Agricultural Heritage System, a designation being developed by the United Nations Food and Agriculture Organization and UNESCO. The semi-arid landscape centered on the Painted Desert would be the first area in North America to receive this honor. For further information of the progress of this proposed designation, call the Center for Sustainable Environments at 928-523-0637 or see the Center's website, www.environment.nau.edu.

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