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Southwest Agroforestry Action Network

A Peek at Indigenous Agroforestry in the Southwest

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with support from

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Trees, Water & People

Southwest Agroforestry Action Network

Note to reader

This synthesis is one part of a collaborative project that is conducted by Indigenous land stewards who have contributed to the roles of consultants, writers, researchers, and filmmakers. Included in this project are case studies in the form of video storytelling and information sheets that feature Flowering Tree Permaculture Institute, Santa Ana Pueblo Nursery, and Española Healing Foods Oasis.

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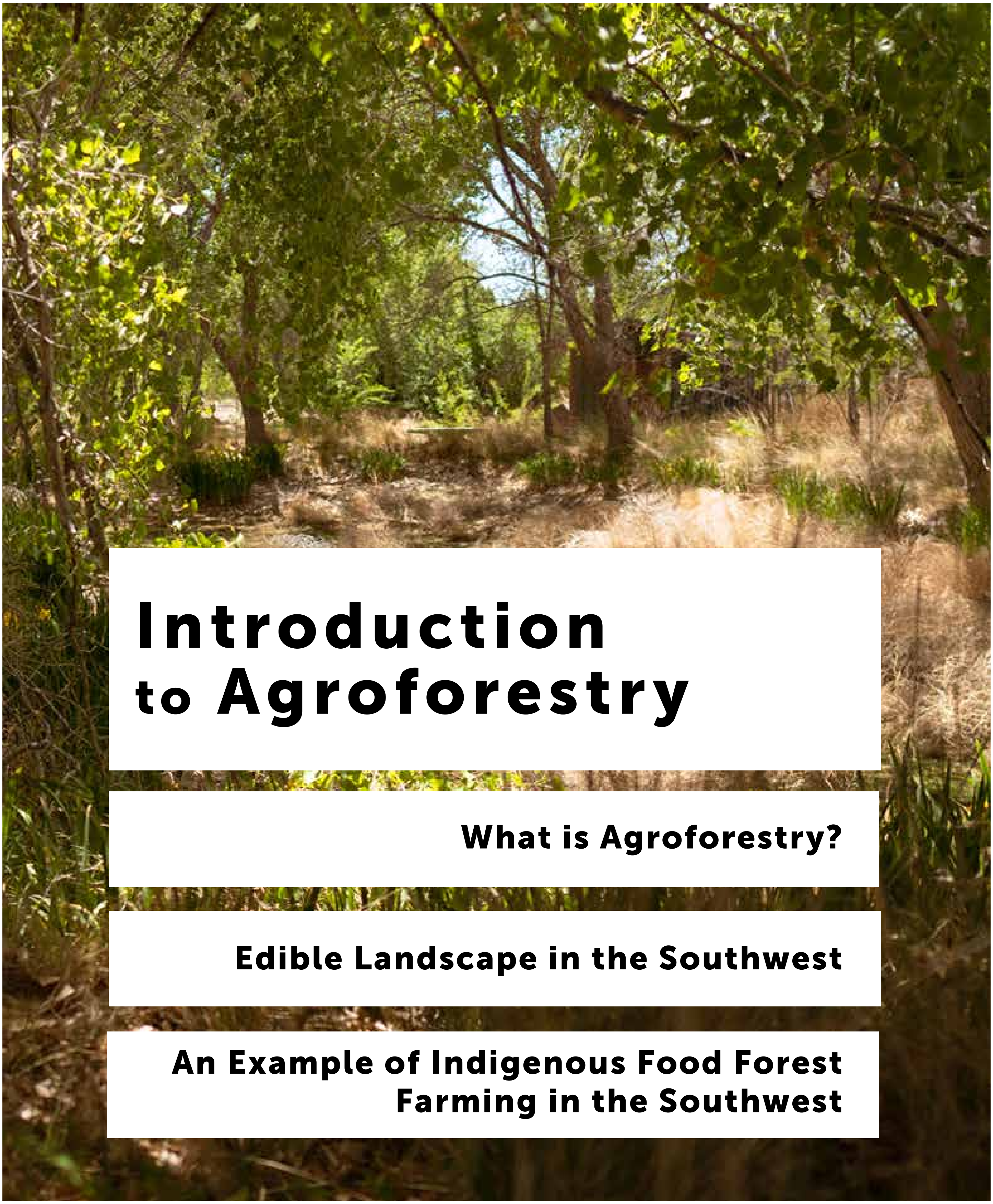
Land Acknowledgment

The ancestral farming systems and traditional ecological knowledge presented are Indigenous practices recorded from Southwest tribes, ranging from the Colorado Plateau to the Sonoran Desert in Mexico. This includes over 50 tribes that are federal/state-recognized and unrecognized. These tribes have ancestral roots that connect to agroforestry and have been cultivating the landscape for food, medicine, and cultural purposes for thousands of years (Doolittle, 2002; Norton, Sandor, White & Laahty, 2007).

Colonial-driven efforts have attempted to erase this ancestral knowledge through genocide, relocation, assimilation, and harmful systemic policies. These actions over the past 500 years are directly correlated to issues in Indigenous communities of loss of land, culture, language, and overall health and wellness.

Community members from Native nations like Zuni Pueblo, Hopi Pueblo, Taos Pueblo, Santa Ana Pueblo, Tesuque Pueblo, Navajo, White Mountain Apache, Tohono O'odham, Rarámuri, and many others have continued to honor and pass on ancestral farming knowledge. These Indigenous farming practices are reflective of current agroforestry values.

This is an introduction to agroforestry in the Southwest. There is much more to explore in other forms of Indigenous traditional ecological practices as well as a vast network of land stewards in the region who are directly engaged with applying agroforestry into their farming and land management systems.



Introduction to Agroforestry

What is Agroforestry?

Edible Landscape in the Southwest

An Example of Indigenous Food Forest Farming in the Southwest

What is Agroforestry?

Agroforestry is a deliberate alliance of growing food and environmental stewardship. It is harmonizing and blending the natural benefits of incorporating perennial plants into agricultural systems. According to the USDA National Agroforestry Center, agroforestry is the intentional integration of trees and/or shrubs with crop or animal production to create environmental, economic, and social benefits (National Agroforestry Center, 2012). The primary agroforestry practices that they focus on are 1) silvopasture 2) alley cropping 3) windbreaks 4) riparian buffers and 5) food forest farming. Silvopasture incorporates livestock and trees to provide shade and sustainable forage options. Alley cropping, windbreaks, and riparian buffers use trees and shrubs to protect the health of the crops, soil, and watershed. Lastly, food forest farming integrates all of these practices as biomimicry of a self-sustaining ecosystem to grow edible and medicinal plants in a purposeful forest setting. Ultimately, these practices have a collective interest in matching the function of a healthy ecosystem in nutrient cycling, watershed management, soil building, pest management, and resilience in biodiversity.

Additionally, there is a multitude of sustainable land-use terms that have been intermixed with agroforestry: agroecology, agropastoralism, ethnoagroforestry, food forests, food landscapes, holistic rangeland management, integrated aquaculture, forest gardening, permaculture, edible landscaping, sustainable agriculture, watershed management, wildlife gardening, and wild harvesting (Holmgren, 2012; Nabhan, 2013; Udawatta & Jose, 2012). These share a commonality in the direction of land stewardship and growing sustainable foodsheds. Additionally, terms like Indigenous agroforestry, dry farming, and traditional ecological knowledge are included in this list.

Edible Landscape in the Southwest

The Southwest climate can be a challenging place to grow food. Annual precipitation is low, ranging from 5-20 inches per year, depending on elevation (Arizona State Climate Office, 2019; DuBois, 2019). In addition to the challenges of growing food in an arid landscape, there is intense sun exposure, with an average of 300 sunny days per year in the Southwest and cycles of wind storms that can dry out plants (Arizona State Climate Office, 2019; DuBois, 2019).

Historically, Indigenous communities were utterly reliant on the landscape for food, fiber, medicine, dyes, and other natural materials. In addition to cultivated foods of corn, beans, and squash, the wild crops found throughout the landscape were “systematically rummaged” to provide additional flavors, nutrients, and diversity to the Indigenous diet (Price & Morrow, 2006, p. 22). A wide range of wild edible plants includes yucca, osha, pinyons, mushrooms, amaranth, cactus, mesquite, acorns, wild onions, sunflowers, currants, and chokecherries, among many others (Price & Morrow, 2006; Salmón, 2012).

To sustain healthy ecosystems and feed communities, Indigenous cultures cultivated a symbiotic and familial bond with the land (Salmón, 2012). Self-sufficiency stems from observing the landscape and recognizing ecological relationships and patterns. This practice is known as traditional ecological knowledge and is the textbook of sustainable land management, Indigenous science, and feeding communities. With this knowledge, Indigenous people tapped into the energy of the ecosystem, enhancing it to cultivate a bountiful edible landscape in an arid southwestern climate. Enrique Salmón, a Rarámuri ethnobotanist, provides an Indigenous perspective of producing an edible landscape, which focuses on blending "community, culture and land management for sustainable use and benefit for the ecosystem and the people" (Salmón, 2012, p. 101). As original land stewards of the region, Indigenous peoples have been utilizing agroforestry practices in ancestral farming systems to feed their communities for thousands of years.

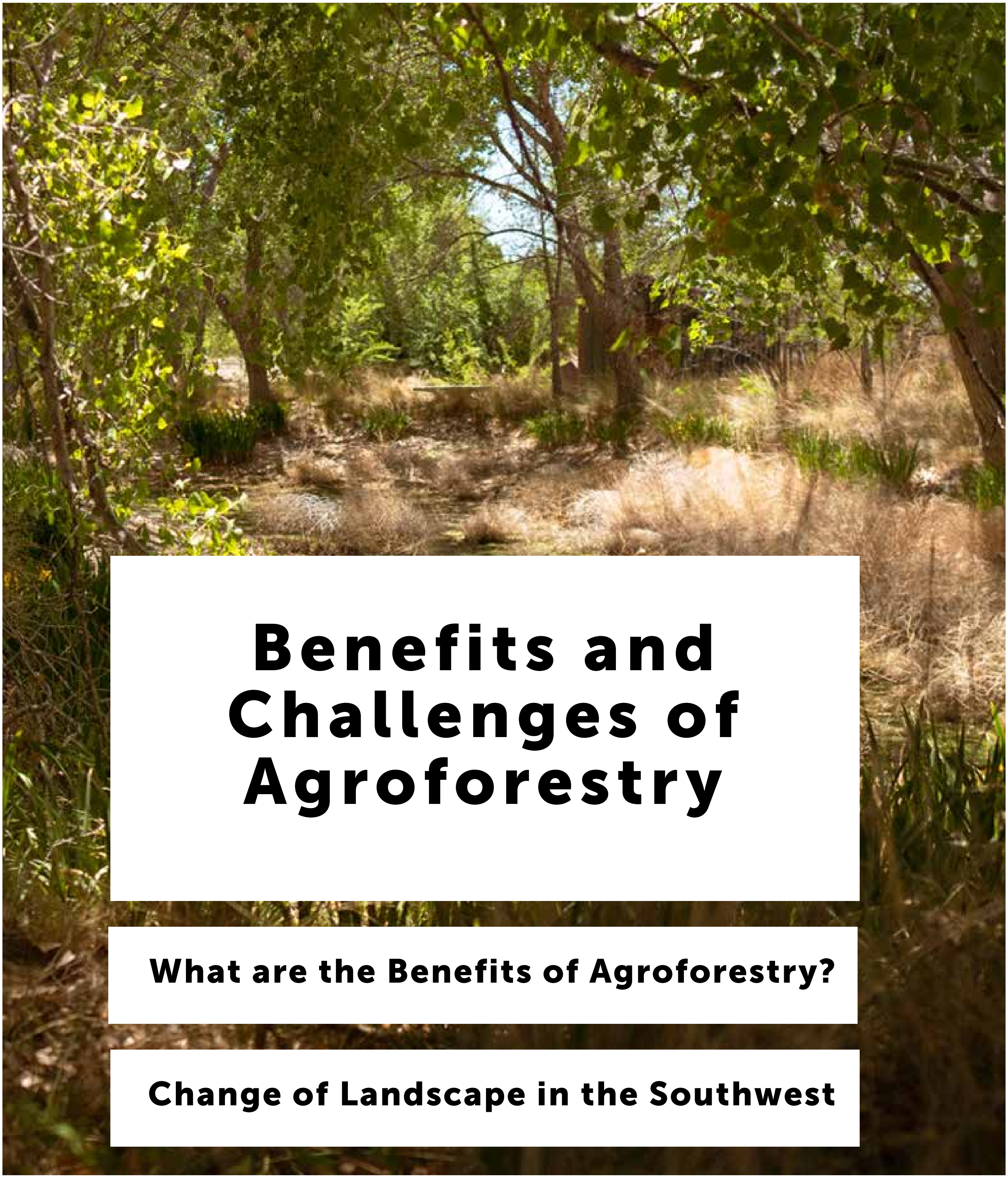
These ancestral practices are still in use today. Many Indigenous farmers continue to practice elements of ancestral agroforestry that reflect silvopasture, windbreaks, alley cropping, riparian buffers, and food forest farming in their agricultural systems, and share their knowledge for future generations.

An Example of Indigenous Food Forest Farming in the Southwest

The Flowering Tree Permaculture Institute is a food forest oasis on ⅛ of an acre that defies the semi-arid landscape of northern New Mexico. This 35-year-old mini forest immediately protected the area from the harsh sun on hot summer days. Roxanne Swentzell, a member of the Santa Clara Pueblo, began this intensive agricultural design by planting a large boulder. It was placed there to slow down water flow and to provide a nurse habitat for initial seedlings.

Now, the boulder is partially buried in the ground, with years of topsoil that naturally collected around. The topsoil in this miniature food forest was dense with nutrients, organic matter, and sediment, which was built up over eight inches in height from the neighboring properties. Not only did the food forest have to survive intense sunlight, but it also had to endure harsh wind cycles and freezing winter temperatures. The growth of this food forest relied solely on the precipitation of the region, yet with the use of integrating livestock and utilizing trees/shrubs as shade and windbreaks, the barren landscape began to wake into a cycle of living.

As the succession of the food forest proceeded, the canopy of the trees provided shade from the sun and protection from frost (Hemenway, 2009). Within the first 10 years of the project, over 500 species were recorded on the small plot of land (Hemenway, 2009). In the forest, there was an explosion of diversity and life in every inch of the area. Along the walls of the hand-built adobe home were grape vines crawling and heavy with fruit. Hidden from view in the dense forest is a small orchard with a few beehives to promote pollination health. Also hidden along the side of the home is a bamboo forest, which has slowly been nursed into cultivation. Bamboo is not native to an arid New Mexico ecosystem. Still, the forest has naturally progressed over time into a cool, shaded, and moist environment for the bamboo to thrive in. Not only is the small forest providing a habitat for the livestock of turkeys, goats, chickens, bees, and rabbits, but it is also providing a refuge for wildlife. This small farm is a phenomenal example of Indigenous agroforestry and is a critical tool for feeding communities and sustainable land management in the southwest.



Benefits and Challenges of Agroforestry

What are the Benefits of Agroforestry?

Change of Landscape in the Southwest

What are the Benefits of Agroforestry?

There are many benefits to agroforestry that range from environmental, economic, and social. The health of the soil, air, and watershed is improved (Garrett et al., 2022; Jose, 2009; Jose, 2012; Jose & Bardhan, 2012; Kumar & Jose, 2018). Additionally, there is the opportunity for a diversification of income and local economies.

The intercropping of perennials adds to the complexity of the layers of roots in an agroforestry system, accumulating minerals and nutrients, and cycling them as an organic mulch on the surface for the benefit of other plants (Jose, 2009; Kumar & Jose, 2018). As species richness and biodiversity improve, this creates a more resilient landscape that can recover quickly from damaging natural forces (Jose, 2012; Jose & Bardhan, 2012; Schoeneberger, Bentrup & Patel-Weynand, 2019). Agroforestry can help mitigate and protect from natural disasters and other damaging crises that can occur to the farmer, rancher, and surrounding communities. The planting of millions of trees and thousands of kilometers of windbreaks on the Great Plains in response to the Dust Bowl, and in China in response to the degradation of agricultural lands, are two examples of how an agroforestry practice has helped to mitigate damage and restore the productivity of degraded farms and rangeland on a very large scale (Brandle et al. 2004; Garrett et al., 2022).

Agroforestry practices also provide protection for livestock, crops, and wildlife, which strengthens crop productivity and biodiversity. Windbreaks modify nearby microclimates by limiting the effect of winds drying out crops and creating thermal zones that pocket solar radiation. Studies of windbreaks on the Great Plains (with a variety of crops, soil types, and production systems evaluated) show an increase in crop yields ranging from 10-16 percent, with other studies showing a 56 percent increase in crop yield (Schoeneberger, Bentrup & Patel-Weynand, 2019; Watts, 2019). By decreasing the intensity of wind velocity, the windbreaks and integration of trees and shrubs can improve the overall health and vitality of the crops.

In addition to increased crop yield, agroforestry can provide renewable biomass production. Strategic management can sustainably harvest trees to replace some of the need for fossil fuel production (Udawatta & Jose, 2012; Watts, 2019). To also mitigate fossil fuel production, agroforestry has a high capacity for long-term carbon sequestration. A report by the Intergovernmental Panel on Climate Change indicates agroforestry has more capacity for carbon sequestration than current management practices in wetland restoration, restoration of degraded lands, forest and grazing management, and rice and cropland management (Jose, 2009: Udawatta & Jose, 2012). Additionally, several agroforestry practices are listed among the top approaches for drawing carbon from the atmosphere (Hawken, 2019). With patience and long-term investment, agroforestry practices can yield environmental, social, and economic benefits for current communities and for future generations.

Change of Landscape in the Southwest

Exploitation of natural resources and land has been the driving theme in southwestern land management. The industries of mining, timber, and grazing operations have forever changed the southwest landscape. Wear and tear is evident in the landscape. This has led to springs drying up, groundwater and aquifer depletion, and arroyo cutting (Salmón, 2012; Webb & Leake, 2005). The overexploitation of water and natural resources has contributed to woody plant encroachment, fire suppression, pest and disease outbreaks, invasive species, and land degradation (Webb & Leake, 2005). Environmental disasters are becoming more prevalent with increasing temperatures and unpredictable weather patterns.

For example, in the Navajo Nation, a report for the United Nations recorded "trends of increasing temperature and lower amounts of snowfall (and precipitation) have led to increasingly arid conditions" (Margaret Redsteer et al., 2011). Additionally, with several centuries of open grazing of cattle, sheep, goats, and horses, biodiversity on

Navajo rangeland is reduced with vegetation cover ranging from 9.5-17 percent (Thomas & Redsteer, 2004). The combination of vegetation loss, higher temperatures, and lower precipitation has led to an increase in active sand dunes, which threaten Navajo homes and livelihoods (Magill, 2014). Measurements of dune migration located near Grand Falls, Arizona, reveal that the average dune moves 115 feet per year (Redsteer, 2011).

Even forest health was altered by grazing. A study conducted on the Chuska Mountains in the Navajo Nation recorded a more extended period of fire exclusion starting from the 1830s, compared to other regions where fire exclusion began around the 1870s (Whitehair, Fulé, Meador, Taracón & Kim, 2018). The act of fire exclusion focuses on suppressing the natural cycle of fire regime in a forest, grass, or shrub habitat as a way to protect livestock, lumber, and nearby growing communities.

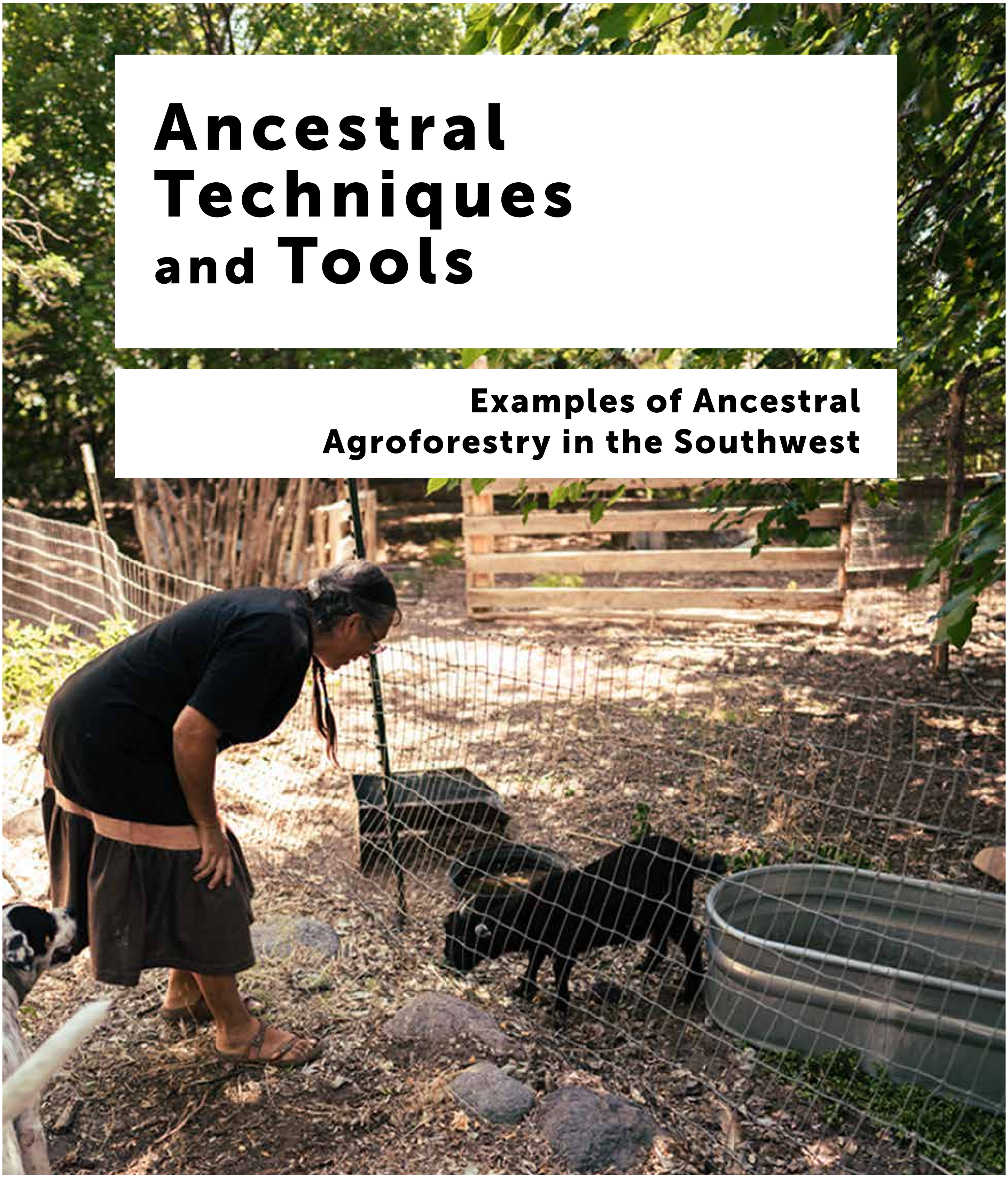
Populations of livestock in the southwest continued to grow at a rapid rate. Livestock surveys in the late 1800s estimated cattle populations peaking at 40 million, with overgrazing and desertification becoming alarmingly evident on the landscape (Holchek, Pieper & Herbel, 2011). Desertification created conditions for invasive species to thrive, with little competition from the struggling native ecosystem.

Another change in the landscape that has occurred is invasive species, such as tamarisk, which thrive in new and disturbed habitats, and monopolized southwestern riparian ecosystems. Watersheds were altered by the construction of extensive water diversion structures that impeded seasonal flood regimes, and keystone species such as beavers were removed from the ecosystem (Webb & Leake, 2005).

The biggest challenges continue to lie ahead. As current conditions worsen, even the most strategic land management practices will be facing a threat in environmental disasters such as extreme forest fires. In a 2019 study on the Navajo Nation forests, it is estimated that by the end of the century, these forests will be reduced by 65-89 percent (Yazzie, Fulé, Kim & Meador, 2019). This radical change in forest density will threaten the biodiversity and functions of the ecosystem. These studies conducted on the Navajo Nation are a small reflection of what is happening on a global scale. Agroforestry can help counter these desperate times.

Ancestral Techniques and Tools

Examples of Ancestral Agroforestry in the Southwest



Examples of Ancestral Agroforestry in the Southwest

When looking at agroforestry practices in the Southwest, it is important to recognize the ancestral knowledge and sustainable technology that Indigenous people have utilized to cultivate the landscape. Stewardship and place-based ecological knowledge enable the ability to gain an intimate perspective of the local region to encourage microclimates that nurture plant establishment.

In the Southwest, Indigenous dry farming and ancestral agroforestry center on harvesting water and watershed management. These practices are dependent on the runoff of seasonal precipitation; it is critical to capture this periodic flow of water on the landscape. To do this, practical farming systems such as water weirs, terrace gardens, waffle gardens, living fences, and rock mulch are used to disperse the flow of water, retain soil moisture, and disperse organic sediment throughout the watersheds (Homburg & Sandor, 2011; Price & Morrow, 2006; Salmón, 2012). Studies have shown that the impact of these dry farming systems increases topsoil depth, bank overflow, herbaceous cover, water saturation, and nutrients available in the soil (Nichols & Polyakov, 2019; Nichols, Polyakov, Nearing & Hernandez, 2016; Norton, Bowannie, Peynetsa, Quandelacey & Siebert, 2002; Polyakov, Nichols, McClaran & Nearing, 2014; Sandor et. al, 2007). These ancestral agroforestry systems are just a few examples of the tools used by Indigenous people of the region.

Location

Slopes are key to the location. Naturally-angled areas such as arroyos, washes, valley floors, and along their edges can promise a concentration of precipitation, as well as beneath cliffs and next to canyon walls (Hack, 1942; Morrow & Price, 1997; Price & Morrow 2006; Salmón, 2012). These observed locations of water disbursement are ideal microclimates that provide extra nutrients and protection to crops.

Soil

The quality of soil is also a significant value to agricultural locations. Loamy sandy soils that act as a sponge and allow for subsurface soils to maintain moisture are ideal (Sandor et al., 2007). These loamy sands can be found in alluvial fans, which are locations consistently saturated by seasonal precipitation and receive periodic water flow from washes, canyons, or channels from mesa tops. Not only do alluvial fans provide soft soils for planting, but they are in the direct route of monsoon and winter storms and sediment deposits from upslope locations (Sandor et al., 2007). Additionally, sandy deposits and sand dunes are used as dry farming locations. Some of these dunes can be found on top of mesas or windblown against a sloped location (Hack, 1942). Precipitation is absorbed in the sand dunes and the top layer of loose sand acts as a mulch and limits evaporation (Hack, 1942; Price & Morrow, 2006). This choice of location is evident in where Hopi, Zuni, and Navajo farmers have strategically placed their peach trees in sandy soil deposits found below a mesa top or canyon edges (Muench; Wytsalucy, 2019). During monsoons, the mesa slopes above the peach trees direct runoff and the water soaks into the sandy deposits, saturating the roots of the fruit trees.

In addition to an increase in water and the quality of soil in these strategic locations, there is a “traveling compost slurry” of nutrients that flows with the water downstream and is deposited along the banks, in the washes, and directly into these farming sites (Nabhan, 2013; Norton, Pawluk, & Sandor, 1998; Salmón, 2012). This slurry consists of plant litter, duff, and topsoil from higher-elevation forest types, such as pinyon-juniper woodlands, which is referred to as “tree sand” by Zuni farmers (Price & Morrow, 2006; Sandor et al., 2007). Studies from Zuni farms in the early 2000s showed an increase in organic matter, nitrogen, phosphorus, and mycorrhizae in these areas of agricultural practices (Norton, Sandor, White, Laahty, 2007; Price & Morrow, 2006; Sandor et al., 2007). This continual renewal of organic matter also builds the height of the soil (Norton, Sandor, and White, 2002; Sandor et al., 2007). The precipitation-based cycle of sediment deposit aids in soil health for agricultural areas, and is vital to long-term sustained agrarian productivity as well as watershed conservation (Sandor et al., 2007).

Water weirs

Water weirs, or small dams, are placed in ephemeral streams to slow down the flow of water and disperse it across the landscape. Water weirs vary in construction, with materials using either brush or rocks as a dam structure. They are typically staggered, with multiple water weirs strategically placed along a wash or arroyo (Wilken, 1987). Agricultural fields are placed below and alongside the water weirs, and can be made a year before planting in the field to collect nutrients and sediment deposits that accumulate from the water weir (Polyakov, Nichols, McClaran & Nearing, 2014; Sandor et al., 2002). These fertile locations created by the water weirs are ideal for incorporating agroforestry practices, like interspersing trees and perennial plants into the agricultural systems.

Studies of Zuni brush water weirs showed that the structures trapped silt traveling with the water flow, with sediment deposition extending 100 meters upstream from the weir and an increase of water saturation in the watershed (Norton, Bowannie, Peynetsa, Quandelacey & Siebert, 2002). These conditions created nutrient-dense microclimates, which led to more herbaceous cover along the banks of ephemeral streams, leading to the stabilization of the banks, which contributed to erosion control (Norton, Bowannie, Peynetsa, Quandelacey & Siebert, 2002; Sandor et al., 2007).

Terrace

Terraces can cover expansive regions on landscapes and are long-lasting. Ancestral terraces, also known as trincheras, are located in the Sonoran and Chihuahuan deserts in Mexico; they are documented to be over 500 years old (Nabhan, 2013; Rodriguez & Anderson, 2013; Wilken, 1987). The terraces take advantage of any slope in a region and can be expansive in size, with some systems ranging over a 50-mile radius to feed local communities.

Terraces maximize water saturation on a hillside by creating many micro-watersheds that reduce erosion while improving soil quality and plant productivity (Wei, et al., 2016, p.392). The terrace walls are reinforced with soil, rock, or perennial plants such as agave (Rodriguez & Anderson, 2013; Sandor & Homburg, 2017; Wilken, 1987). Many other perennial plants and trees can be utilized in the terrace system, such as fruit and nut trees, and mesquite, which is a native species that adds nitrogen to the soil.

Waffle

Waffle systems are earthen grids with ridges that limit the loss of water flowing on the landscape. The earthen walls range in height from a few inches to as high as 15 inches (Price & Morrow, 2006; Salmón, 2012). Each segment, or "hood," of the waffle creates individual microclimates for plants to establish (Nabhan, 2013). The developed walls offer multiple functions, such as providing partial shade from the sun, a wind barrier, and a direct concentration of water saturation in the soils; with seasonal precipitation, the walls can hold in water and deliberately saturate the plants and their roots (Salmón, 2012). Perennials and trees are easily incorporated into these systems and can be added to perimeters or intermittently placed to provide protection.

Rock mulch

Traditional ecological knowledge has observed the collection of rain runoff in the sandy soils under river pebbles and gravel, which has led to utilizing this water harvesting method by using rock mulch in agricultural fields (Salmón, 2012). There are several ways that the rock mulch is utilized. Locally-sourced stones, cobbles, or pebbles are collected and lined garden grids. Rock mulch can also be used as a pile that surrounds the base of plants. This adds protection from the wind and sun and minimizes evaporation (Nabhan, 2013). Additionally, the soil temperature is extended into the night when the rocks radiate passive solar heat (Lightfoot & Eddy, 1994; Lightfoot & Eddy, 1995; Salmón, 2012). These microclimates create ideal environments for nurse seedling plants.

Another use of rock mulch is found in ancestral pebble gardens along the Rio Grande in northern New Mexico. These are xeriscaped areas of harvested pebbles that are deliberately layered onto the majority of the surface of the agricultural sites (Lightfoot & Eddy, 1995; Price & Morrow, 2006). In addition to controlling weeds, studies have shown that the rough surface of the pebbles reduces wind velocity and stabilizes the soil, reducing erosion from wind and runoff (Lightfoot & Eddy, 1995; Sandor & Homburg, 2017).

Boulders and rocks were part of the beginning stages of creating the food forest at the Flowering Tree Permaculture Institute in New Mexico. The rock mulch helps stabilize the soils from rain runoff on a hillside, collects organic matter, and establishes microclimates for seedlings.

Living fences

Living fences are used in floodplain management and play a role as windbreaks. The fences can vary; they can be a single row of trees or shrubs that is deliberately planted in rows, on the perimeter of the agricultural field, or placed on the outside of the field in the direct path of flood or wind patterns. These living fences can also be integrated into the use of water weirs, terraces, and waffle farming systems.

Living fences provide multiple benefits of protecting fields from floods, erosion, and animal grazing (Nabhan, 1977; Nabhan, 2013). Microclimates are created by living fences that provide shade and function as a windbreak. They also protect the soil from drying out from the sun and wind (Salmón, 2012). The living fences strengthen biodiversity by providing a habitat for birds, who contribute to natural pest management by eating insects that may be in the agriculture fields (Nabhan, 1977; Nabhan, 2013).

Living fences also produce a renewable source of biomass. Species like willows and cottonwoods can be thinned, coppiced, and periodically harvested, with the stumps continuing to regenerate into the living fence (Moreno-Calles, et al., 2016; Nabhan, 1977; Nabhan, 2013). Fruit and nut trees and other agricultural trees can be considered in living fence systems.

Agroforestry Now

Currently, ancestral agroforestry systems are being used in watershed restoration projects to control erosion and reduce the incising of gullies, arroyos, and washes (Nichols & Polyakov, 2019; Nichols, Polyakov, Nearing & Hernandez, 2016; Polyakov, Nichols, McClaran & Nearing, 2014). Studies using rock weirs for watershed restoration in southern Arizona had similar results as the brush water weirs in Zuni Pueblo, showing an increase in water saturation from monsoon runoffs and an increase of organic materials from sediment accumulation behind the check dams (Polyakov, Nichols, McClaran & Nearing, 2014; Sandor et. al, 2007).

The studies show a decrease in channel slope with the added soil from the silt deposits, a decrease in peak discharge with the energy of high flood waters slowing down, and an increase in bank overflow and water saturation in the surrounding soils (Nichols & Polyakov, 2019; Nichols, Polyakov, Nearing & Hernandez, 2016; Norton, Bowannie, Peynetsa, Quandelacey & Siebert, 2002; Polyakov, Nichols, McClaran & Nearing, 2014). Essentially, the velocity of water during storms is forced to slow down as it travels through these agricultural systems. During a time of extreme natural disasters, this is a low-cost method that could help minimize flood dangers to surrounding communities.

Similarly, with the use of terraces, rock mulch, and living fences, studies have shown that these agricultural systems all show an increase in water infiltration and retention, and an increase of organic nutrients, like nitrogen and phosphorus, which increase biomass and crop yield (Lightfoot & Eddy, 1994; Lightfoot & Eddy, 1995; Price & Morrow, 2006; Salmón, 2012; Sandor & Homburg, 2017; Wilken, 1987). Soil health is improved. Sediment is deposited in the fields, adding a new layer of fertile topsoil and slowly expanding the area of arable land (Moreno-Calles, et al., 2016; Nabhan, 1977; Nabhan, 2013).

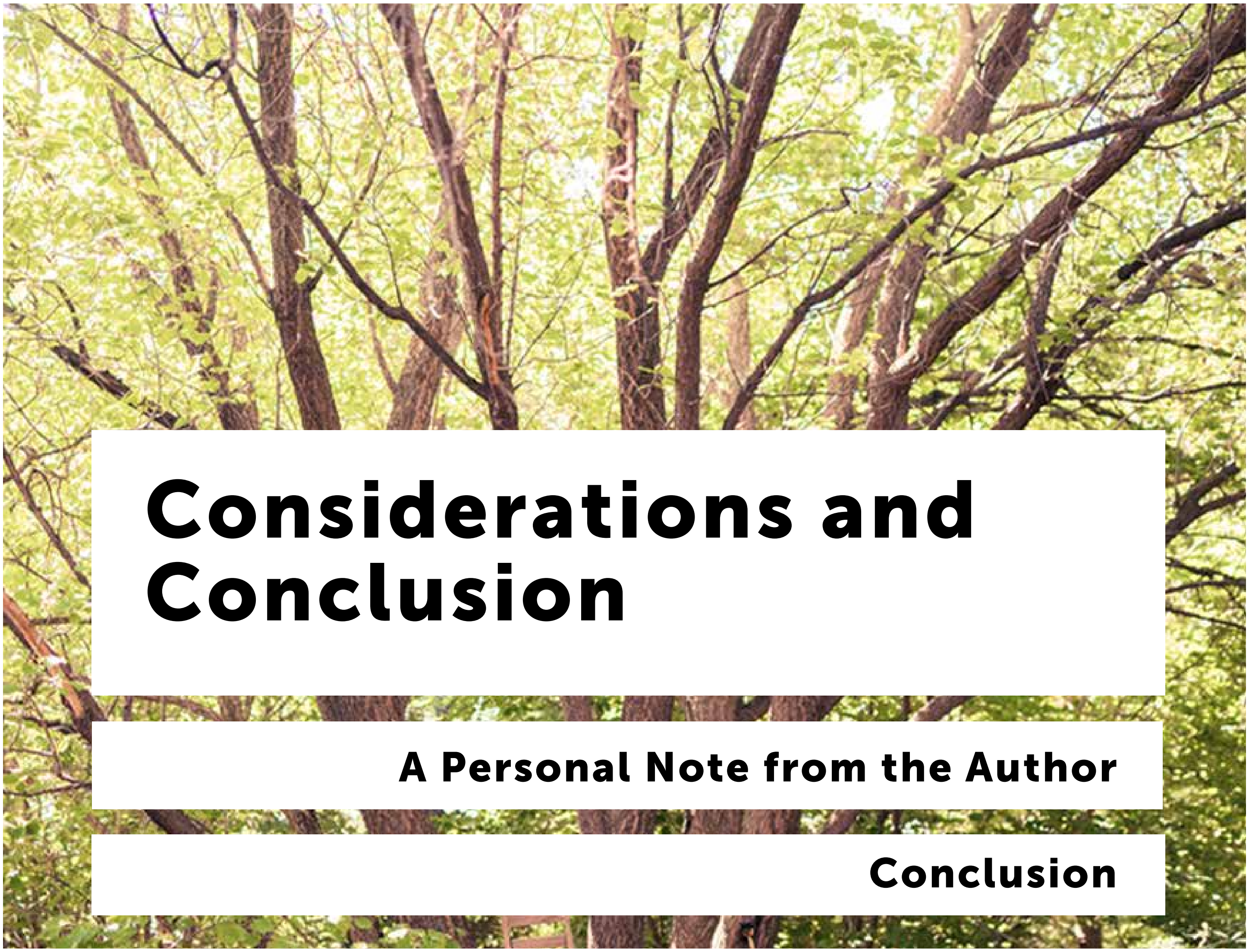
Modern practices of agroforestry systems of silvopasture, alley cropping, windbreaks, riparian buffers, and food forest farming are currently being utilized by farmers, ranchers, and land managers in the Southwest. Grazing livestock have been in national forests and areas of timber harvesting. Orchards and nut tree production, like pecans, are being integrated with grazing livestock. These practices help ranchers and farmers maintain the integrity of the land while improving its ability to receive and retain water and nutrients (Adams, 2022).

Trees and shrubs are being applied as windbreaks to provide natural protection to crops and livestock. Native medicinal and edible plants are being integrated into agricultural systems. These are strengthening and adding to biodiversity, a key element of agroforestry. A more modern take on agroforestry is incorporating solar panels with grazing and crop production. Programs like the American Solar Grazing Association are integrating solar farms to provide shade and a microclimate for ranching and farming purposes.

There is a web of researchers, land managers, farmers and ranchers, and community members who are cultivating various forms of agroforestry, traditional ecological knowledge, and sustainable land management in the Southwest. A few of these programs are the:

- Hopi Tutskwa Permaculture Institute
- Four Bridges Traveling Permaculture Institute
- Spirit Farms
- Ts'uyya Farm
- Flowering Tree Permaculture
- Santa Ana Pueblo Native Plant Nursery
- Tewa Women United Healing Oasis
- Institute of American Indian Arts
- Traditional Native American Farmers Association
- Red Willow Center
- Central Rocky Mountain Permaculture Institute
- Cedar Agroforestry
- Native American Food Sovereignty Alliance
- Southwest Agroforestry Network
- Linking Edible Arizona Forests
- Native Seeds/SEARCH
- Arcosanti
- Dryland Agroforestry Research
- Mission Garden

On a broader scale, there are agroforestry hubs nationwide, such as the Texas Agroforestry Small Farmers and Ranchers, Savannah Institute, and National Agroforestry Center. These associations advocate for edible landscapes and the preservation of heirloom species that have adapted to the climate. There is a focus on bioregional food systems and creating distinctive, lush oases for future generations.



Considerations and Conclusion

A Personal Note from the Author

Conclusion

A Personal Note From the Author

As a landless Indigenous farmer, I have worked with many Indigenous land stewards with and without direct access to land and resources. These are the folks who are cultivating ancestral foodways with modern technology in order to open up pathways to healthy foods in their communities. These communities have faced multiple generations of colonization attempts to separate and abolish these seemingly savage cultural practices, yet now this ancestral knowledge presents a sensible guide to living abundantly in an arid climate.

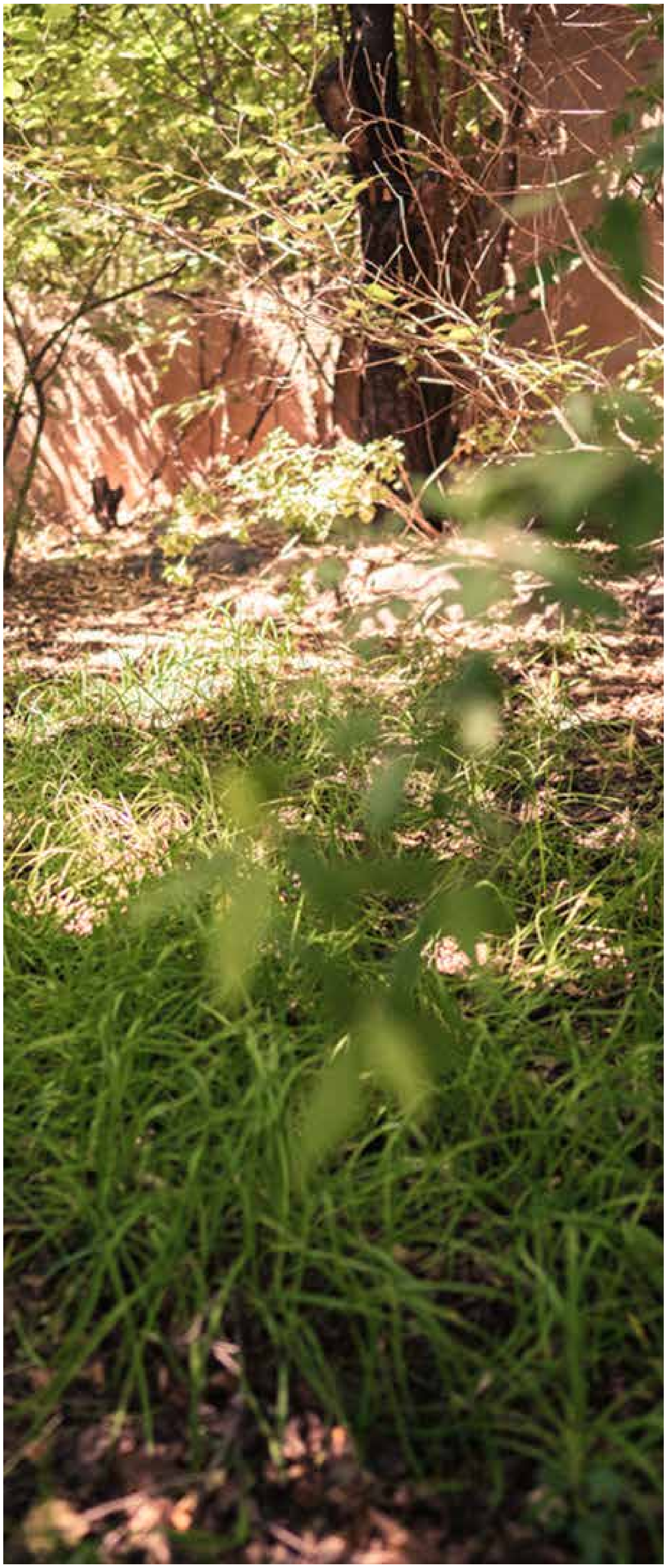
In my experience, direct access to Indigenous lands for farming and ranching purposes is irregular, multi-faceted, and not easily accessible to tribal members. There are a number of Indigenous farmers who are leading the path of Indigenous agroforestry and who are relying on the use of land outside of tribal lands for their projects. Less than one-third of tribal members currently live on Indigenous lands, and many of these households are overcrowded (Native Marican Living Conditions Today). These stats alone show that there is a direct need for equitable and long-term access to lands to be made available to current and future generations in order for folks to have the ability to grow food for themselves and their communities. This can encourage food security at a local level.

Additionally, in order to encourage farmer and rancher success with Indigenous agroforestry practices, there is a need for equitable access to resources that are directly available to Indigenous individuals, businesses, or collectives. Further support could look like living stipends, micro-grants, health insurance coverage, mental health and wellness support, and providing technical assistance. This added support will help Indigenous individuals and communities continue to be leaders and educators in feeding locally in a culturally appropriate manner.

Conclusion

Agroforestry promises an oasis in the Southwest. Land managers and stewards have the opportunity to apply place-based traditional ecological knowledge and agroforestry methods to revitalize and restore an edible landscape. The result brings in a reciprocal abundance of food and natural resources and enhances ecosystem functions and services. The utility of these agroforestry practices provides benefits of soil building, water harvesting, distribution of nutrients, and erosion control.

There is growing interest and demand for agroforestry. Current efforts in watershed management, agroecology, conservation, and forestry are revisiting ancestral ecological knowledge and agroforestry methods that work with the arid ecosystems of the Southwest. By applying ecological knowledge, locations on the watershed are identified that are frequently saturated from seasonal precipitation. Traditional structures can then be applied with current agroforestry methods to create fertile microclimates for restoration and rehabilitation treatments. Additionally, during times of climate change and extreme environmental disasters, these agroforestry systems can help protect and minimize the negative impacts on surrounding communities. New Mexico needs replanting over 2.5 million acres impacted by wildfires, yet the current capacity for growing seedlings is limited (New Mexico Legislature, 2022). The use of agroforestry in land management systems can help address these demands.



There is an opportunity to start agroforestry practices on a small or large scale. A key to learning about the bioregion and practicing traditional ecological knowledge is to be curious. Look into local resources, learn of native and adapted agricultural practices, and observe where water will be planted to enhance the edible landscape.

Citations

- Adams, A. (2022). Mixing Pecans with Livestock for Profit in New Mexico. 2023, https://holisticmanagement.org/featured-blog-posts/mixing-pecans-with-livestock-for-profit-in-new-mexico/
- Arizona State Climate Office. (2023). Arizona climate. Arizona State University, retrieved from: https://azclimate.asu.edu/climate/
- Brandle, J. & Hodges, Laurie & Zhou, Xinhua. (2004). Windbreaks in North American agricultural systems: New visitas in Agroforestry. Agroforestry Systems. 61. 10.1023/B:AGFO.0000028990.31801.62.
- Doolittle, W. E. (2002). Cultivated landscapes of Native North America. Oxford University Press.
- DuBois, D. (2023). Climate in New Mexico. New Mexico Climate Center: New Mexico State University. Retrieved from: https://weather.nmsu.edu/climate/about/
- Garrett, H. E. G., Jose, S., & Gold, M. A. (Eds.). (2022). North American Agroforestry (Third). ACSESS.
- Hack, J. T. (1942). The changing physical environment of the Hopi Indians of Arizona: Reports of the Awatovi expedition. Cambridge, Massachusetts: Peabody Museum of American Archaeology and Ethnology.
- Hawken, P. (2019). Drawdown: The most comprehensive plan ever proposed to reverse global warming. Langara College.
- Hemenway, T. (2009). Gaia's garden. White River Junction, Vermont: Chelsea Green Publishing.
- Holchek, J. L., Pieper, R. D. & Herbel, C. H. (2011). Range Management: Principles and Practices. Pearson. 17-30.
- Holmgren, D. (2012). Essence of permaculture. Holmgren Design Services.
- Homburg, J.A. & Sandor, J.A. (2011). Anthropogenic effects on soil quality of ancient agricultural systems of the American Southwest. Catena, 85, 144-154. doi:10.1016/j.catena.2010.08.005
- Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: an overview. Agroforestry Systems, 76, 1-10. Doi: 10.1007/s10457-009-9229-7

- Jose, S. (2012). Agroforestry for conserving and enhancing biodiversity. Agroforestry Systems, 85. 1-8. Doi: 10.1007/s10457-012-9517-5
- Jose, S. & Bardhan, S. (2012). Agroforestry for biomass production and carbon sequestration: an overview. Agroforestry Systems, 86, 105-111.
- Kumar, M. & Jose, S. (2018). Phenotypic plasticity of roots in mixed tree species agroforestry systems: review with examples from peninsular India. Agroforestry Systems, 92, 59-69.
- Lightfoot, D., & Eddy, R. (1994). The agricultural utility of lithic-mulch gardens: Past and present. GeoJournal, 34(4), 425-437.
- Lightfoot, D., & Eddy, R. (1995). The construction and configuration of Anasazi pebble-mulch gardens in the northern Rio Grande. American Antiquity, 60(3), 459-470.
- Muench, J. (1950). The Hopi Indian Village of Hotevilla on the Third Mesa, Ariz. This village with terraced fields on slopes that reach down into Dinne-bito Wash. The Hopis are the finest dry farmers known. This pueblo was founded in 1906 when quarrels in the mother village of Oraibi led 300 Hopis to leave it and start this new community. [Photographer's caption]. photograph, Northern Arizona University. Retrieved 2023, from https://archive.library.nau.edu/digital/collection/cpa/id/13926/rec/2.
- Moreno-Calles, A., Casas, A., Rivero-Romero, A., Romero-Bautista, Y., Rangel-Landa, S., Fisher-Ortiz, R., … Santos-Fita, D. (2016). Ethnoagroforestry: Integration of biocultural diversity for food sovereignty in Mexico. Journal of Ethnobiology and Ethnomedicine, 12(1).
- Morrow, B. H. & Price, V. B. (1997). Anasazi architecture and American design. Albuquerque, NM: University of New Mexico Press.
- Nabhan, G. P. (1977). Living fencerows of the Rio San Miguel, Sonora, Mexico: Traditional technology for floodplain management. Human Ecology, 5(2), 97-11.
- Nabhan, G. P. (2013). Growing food in a hotter, drier land: Lessons from desert farmers on adapting to climate uncertainty. White River Junction, Vermont: Chelsea Green Publishing.
- National Agroforestry Center, What is Agroforestry? (2012). Retrieved from: https://www.fs.usda.gov/nac/assets/documents/workingtrees/infosheets/WhatIsAgroforestry07252014.pdf

- Native American Living Conditions Today. Partnership With Native Americans. (n.d.). http://www.nativepartnership.org/site/PageServer?pagename=pwna_living_conditions#:~:text=About%2030%25%20of%20the%205.2,%2C%202004%2C%20Gallup%20Independent).

- New Mexico Legislature. (2022). New Mexico Reforestation Center. Retrieved from: https://www.nmlegis.gov/handouts/EDPC%2007142 2%20Item%204%20NMRC%20Fact%20Sheet.pdf

- Nichols, M. H. & Polyakov, V.O. (2019). The impacts of porous rock check dams on a semiarid alluvial fan. Science of the Total Environment, 664, 576-582.

- Nichols, M. H., Polyakov, V.O., Nearing, M.A. & Hernandez, M. (2016). Semiarid watershed response to low-tech porous rock check dams. Soil Science. doi: 10.1097/SS.0000000000000160

- Norton, J.B., Bowannie Jr., F, Peynetsa, P., Quandelacey, W. & Siebert, S.F. (2002). Native American methods for conservation and restoration of semiarid ephemeral streams. Journal of Soil and Water Conservation, 57(5), 250-258.

- Norton, J.B., Pawluk, R. R., & Sandor, J. A. (1998). Observation and experience linking science and indigenous knowledge at Zuni, New Mexico. Journal of Arid Environments, 39, 331-340.

- Norton, J. B., Sandor, J. A., & White, C. S. (2002). Hillslope soils and organic matter dynamics within a Native American agroecosystems on the Colorado Plateau. Soil Science Society of American, 67, 225-234.

- Norton, J. B., Sandor, J. A., White, C. S., & Laahty, V. (2007). Organic Matter Transformations through Arroyos and Alluvial Fan Soils within a Native American Agroecosystem. Soil Science Society of America Journal, 71(3), 829–835. doi: 10.2136/sssaj2006.0020

- Polyakov, V. O., Nichols, M.H., McClaran, M.P., & Nearing, M.A. (2014). Effect of check dams on runoff, sediment yield, and retention on small semiarid watersheds. Journal of Soil and Water Conservation, 69(5), 414-421. doi:10.2489/jswc.69.5.414

- Price, V. B., & Morrow, B. H. (2006). Canyon gardens: The ancient Pueblo landscapes of the American Southwest. Albuquerque, NM: University of New Mexico Press.

- Redsteer, M. H. (2011). Monitoring and Analysis of Sand Dune Movement and Growth on the Navajo Nation, Southwestern United States. Flagstaff, AZ: United States Geological Survey.

- Redsteer, M. H., Kelley, K. B., Francis, H., & Block, D. (2011). Disaster Risk Assessment Case Study: Recent drought on the Navajo Nation. United Nations Global Assessment Report on Disaster Risk Reduction 2011. Chapter 3: Drought risks. Pages 1-19.

- Rodriguez, V.P. & Anderson, K.C. (2013). Terracing in the Mixteca Alta, Mexico: Cycles of resilience of an ancient land-use strategy. Human Ecology, 41, 335-349. DOI: 10.1007/s10745-013-9578-8

- Salmón, E. (2012). Eating the landscape. Tucson, Arizona. University of Arizona.

- Sandor, J.A. & Homburg, J.A. (2017). Anthropogenic soil change in ancient and traditional agricultural fields in arid to semiarid regions of the Americas. Catena, 85, 144-154.

- Sandor, J. A., Norton, J. B., Homburg, J. A., Muenchrath, D. A., White, C. S., Williams, S. E., ... Stahl, P. D. (2007). Biogeochemical studies of a Native American runoff agroecosystem. Geoarchaeology, 22(3), 359–386. doi: 10.1002/gea.20157

- Schoeneberger, M. M., Bentrup, G. & Patel-Weynand, Toral. (2019). Agroforestry: Enhancing resiliency in U.S. agricultural landscapes under changing conditions. U.S. Forest Service: United States Department of Agriculture.

- Thomas, K.A. & Redsteer, M. (2004). Vegetation of semi-stable rangeland dunes of the Navajo Nation, Southwestern USA. Flagstaff, AZ: United States Geological Survey.

- Udawatta, R. P. & Jose, S. (2012). Agroforestry strategies to sequester carbon in temperature North America. Agroforestry Systems, 86, 225-242. Doi: 10.1007/s10457-012-9561-1

- Watts, A. (2019). Agroforestry delivers multiple benefits for Great Plains states. Society of American Foresters; Special Edition: Agroforestry, 24 (3), 11. doi:10.3390/su10072246

- Webb, R.H. & Leake, S. A. (2005). Ground-water surface-water interactions and long-term change in riverine riparian vegetation in the southwestern United States. Journal of Hydrology, 320, 302-323. doi:10.1016/j.jhydrol.2005.07.022

- Wei W., Chen D., Wang, L., Daryanto, S., Chen, L., Yu, Y., ... Feng, T. (2016). Global synthesis of the classifications, distributions, benefits, and issues of terracing. Earth-Science Reviews, 159, 388-403.
- Whitehair, L., Fulé, P., Meador, A. S., Taracón, A. A. & Kim, Y. (2018). Fire regime on a cultural landscape: Navajo Nation. Ecology and Evolution, 8(19). 9848-9858. DOI: 10.1002/ece3.4470
- Wilken, G. (1987). Good Farmers. Berkeley, California. University of California Press.
- Wytsalucy, Reagan C., "Explorations and Collaborations on Two Under-Recognized Native American Food Crops: Southwest Peach (Prunus persica) and Navajo Spinach (Cleome serrulata)" (2019). All Graduate Theses and Dissertations, Spring 1920 to Summer 2023. 7612. https://digitalcommons.usu.edu/etd/7612
- Yazzie, J. O., Fulé, P. Z., Kim, Y., & Meador, A. S. (2019). Diné kinship as a framework for conserving native tree species in climate change. Ecological Application, 29(3). 1331-1343.

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