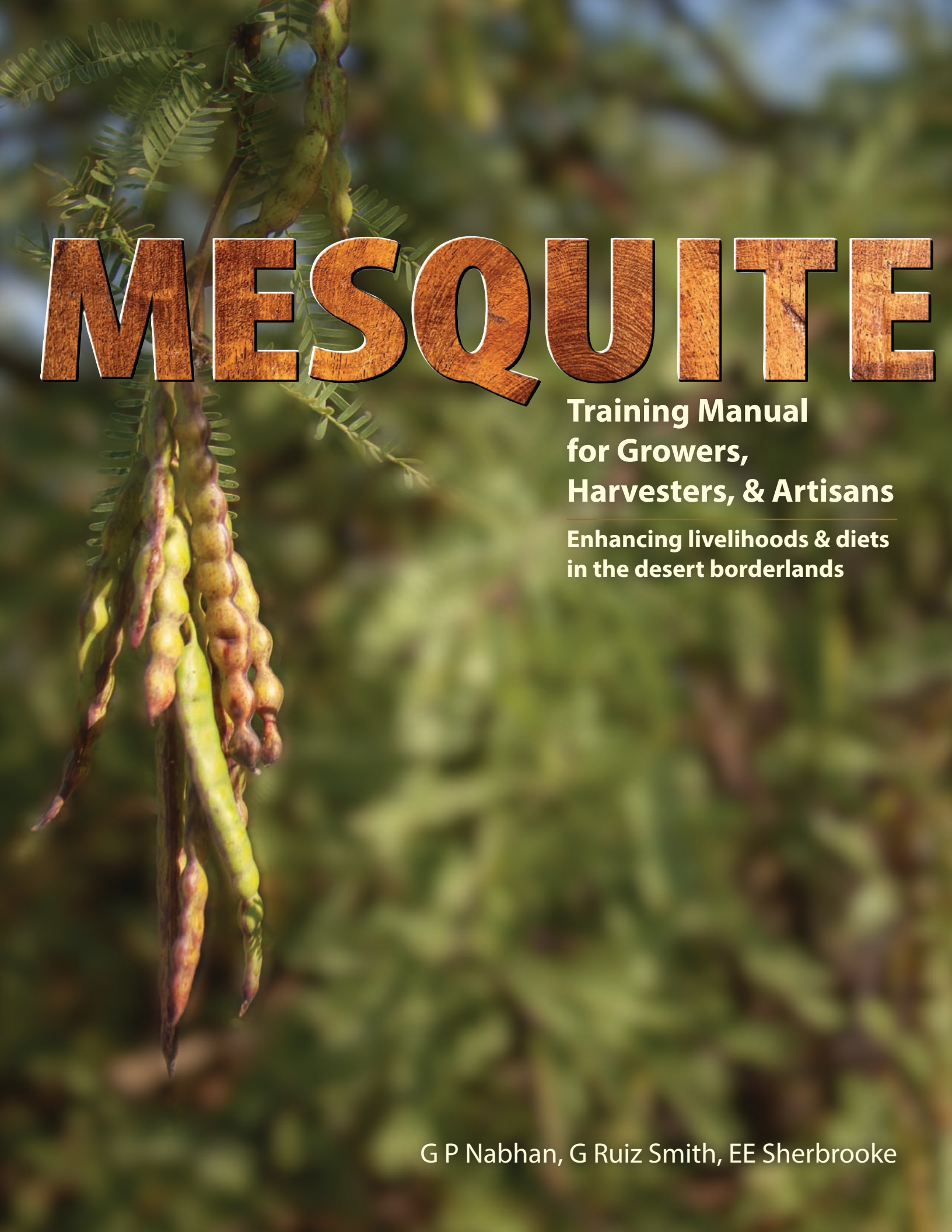

MESQUITE

Training Manual for Growers, Harvesters, & Artisans

Enhancing livelihoods & diets in the desert borderlands

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Gary P Nabhan: 18, 27, 28

Denisse Ortega Lorona: 2, 9, 32, 36, 65 Nick Pitsas, CSIRO: 53 Rhododendrites: 59

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We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

TABLE OF CONTENTS

Dedicated to
Ivan Aguirre and Martha Burgess
and
In memory of
Hugh Fitsimmons III and Richard S. Felger

INTRODUCTION

Gary Paul Nabhan

Imagine that you are driving or biking into any one of a dozen small rural communities on either side of the US/Mexico border in the year 2040. You notice a beautiful building that appears as though it were made of locally sourced materials, situated in a shaded mesquite *bosque* that appears as though it is as meticulously managed as an orchard of high-quality fruit and nut crops.

In fact, these mesquites are being stewarded for their variety of appealing, sustainable, and saleable products: flours and syrups from their pods or "fruits;" fine hardwoods for furniture making, crafts and musical instruments; wines, meads, *mesqals* and probiotic fermented beverages; *liquid smoke* to flavor barbecue sauces, rubs and smoking chips; compost, mulch, and biochar; and honey, propolis, pollen, and gums for medicinal and culinary uses.

You see dozens of visitors milling around a solar-powered hammermill in a courtyard in the middle of a sextagonal building, as two students grind the pods into a fine pastry flour, and a delicious, anti-diabetic mesquite meal. As you glance around the plaza, you see workshops and gift shops where master artisans are teaching young students and older retirees how to craft wooden spoons and forks and musical instruments from mesquite wood; how to assemble mesquite planks into tables and chairs; how to catch the fumes from mesquite chip debris from the furniture makers and turn them into liquid smoke; and how to make medicinal tinctures, musical instruments, and rope from mesquite roots.

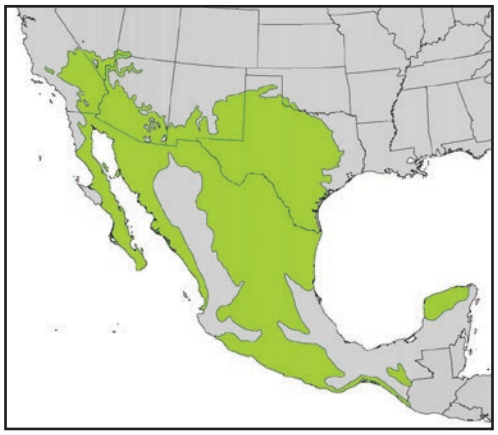
What you are reveling in is one of 12 Mesquite Artisan Training Centers and Showcases that will be found in towns like Los Algodones, California; Patagonia, Sells, and Ajo, Arizona; Agua Prieta, Sasabe, and San Luis, Sonora; Palomitas and Las Mesilla, New Mexico; Janos, Los Algodones, and Ojinaga, Chihuahua; Lajitas, Eagle Pass, and Uvalde, Texas; Musquíz, and Cuidad Acuña, Coahuila. The professional trade training certificates granted to students who intern six months with master artisans at any of these Training Centers are transferable to either side of the border. In addition to training four hours a day with one of six master artisans in residence at any center, student interns are asked to spend two hours a day in the gift shops that market products crafted by both masters and apprentices.

Just why might we need such training centers scattered along the border like so many beads on a multi-colored rosary?

Within each decade, each training center could graduate 500 to 2,000 students, who are then capable of making a decent living in their hometowns using the skills they've acquired. The training

center budgets are funded one-third from sales of products and admission fees for events and workshops; one-third from carbon sequestration credits received for helping nearby ranchers and farmers pull down more carbon to slow climate change; and one-third by community and workforce development offices in each county or municipio. Each master artisan gets paid ten times the minimum wage for every hour she or he teaches others the skills of the trade. A tool library gives access to a hammermill; beekeeping equipment and a canning kitchen are rentable by the half-day at minimal costs by any certificate-holder in Borderland Restoration Network's training courses.

If you think this vision is fanciful, we encourage you to glance at the websites of the Casa del Museo Campesino training centers on Lanzarote in the Canary Islands; the Southern Highland Craft Guild Folk Art Center near Asheville, North Carolina, Via Organica Training Center near San Miguel de Allende, Guanajuato, or the Taos Food Center (of TCEDC) in Taos County, New Mexico. All these analogous training centers have been up-and-running for a decade or more. Those of us who live in the *frontera* of Mexico and the US Southwest desperately need such means for our most celebrated artisans of mesquite products to pass on their skills to others. Thankfully, the Arizona Institute for Resilient Environments and Societies (AIRES) has funded us to jumpstart the process of mesquite-based rural community development through a series of training workshops led by master artisans, and through elaborating this training manual. We now wish to catch up with rural areas in the United States and the rest of the world in offering professional training and employment opportunities so that young people can acquire skills to stay close to home and make a respectable income using their own ingenuity and local resources.



Mesquite Distribution in North America and Central America.

Despite all the media attention given to the 2,000-mile US/Mexico border year after year, residents in rural communities on both sides on the international boundary still suffer from grinding poverty and other problems overlooked by the average citizen in both countries.

Within the US, border counties have twice the level of poverty and food insecurity as the national average. Although some Mexican border towns fare well compared to cities further south in the Republic, rural communities south of the border are being depopulated by lack of access to markets and higher paying jobs, as well as the violence associated with drug transport and human trafficking.

These long-standing dilemmas beg us to ask big questions:

- *What might make borderland communities safer, more stable and prosperous, while providing more livelihoods from local resources that span both sides of the border?*

- *What natural resources and cultural assets in the region can be utilized to offer long-term solutions to the problems of unemployment, underemployment, food insecurity and chronically low wages?*
- *How can the rural skills, hands-on know-how, and bilingual communication skills of borderland citizens be better put to work to restore damaged wildlife habitats, to reduce wildfire risk, to sequester more carbon, and to minimize the impacts of drought, flash floods, and heat waves that are worsening due to climate change?*
- *How can we ensure liveable wages and healthy working conditions for those who choose to labor outdoors, especially since hotter, drier conditions are increasing the frequency of dehydration, heat stroke, heat shock, and accidents triggered by climate anomalies?*
- *How do we deal with the irony that some of these same counties and municipios harbor the highest level of biodiversity anywhere in North America, but have the greatest rates of unemployment?*
- *In other words, if they have an abundance of underutilized natural resources, how can we better manage them to lift rural residents out of poverty?*

Mesquite (*Prosopis* spp.) is one such underutilized resource that can serve as a fulcrum to do that lifting. A mesquite-based restoration economy may help keep in place those who do not wish to leave their homes to cross the border and take refuge in cities for lack of other economic activities.

Disparities in income and access to resources are already the triggers of social conflicts, violence and immigration issues that clearly affect citizens in both Mexico and the United States. They also palpably affect the daily well-being of political and climate refugees emigrating from other countries to this region. That is because many members of rural communities along the border feel they lack sufficient economic capital to resolve a range of economic and social problems affecting their families.

At the same time, many of these rural dwellers have underutilized natural and social capital—such as mesquite trees and the local knowledge and skills to utilize them economically.

Yet, as global temperatures continue to rise, as groundwater levels plummet, and as rivers and reservoirs dry up, there can be little doubt that social conflicts and poverty associated with water scarcity will worsen in the US/Mexico borderlands *if we don't take steps now to shift the dynamics.*

Scewbean mesquite

Velvet mesquite

South American mesquite

How, then do we move toward a cohesive, binational plan with tangible solutions to alleviate these problems?

We feel that a concerted effort to better utilize the many arid adaptations of mesquite trees can leverage new solutions.

BUILDING SOLUTIONS

We need a collaborative initiative—involving communities, governments, foundations, impact investors and other stakeholders—that will heal our degraded landscapes, anticipate climatic changes, draw down more carbon into the soil while reducing greenhouse gas emissions, and create satisfying livelihoods from elaborating value-added food and beverage products, furniture, fuel, and fiber.

The Taos Food Center – operated by the Taos County Economic Development Center - supports the people, cultures, and foods of Northern New Mexico. A commercial kitchen along with business development and marketing assistance help develop and promote local food products.

How can we establish this in a manner that generates a truly restorative, circular economy?

Such an economy based in biocultural restoration can provide residents on both sides of the international boundary with jobs that offer them dignity, liveable wages, and safe, healthy working conditions. Many have called for "disruptive innovations" with the potential to restore the integrity and productivity of both our landscapes and our communities in ways that heal deep historical wounds.

What innovations or technologies will enhance rather than deplete the natural and cultural capital of our region?

We think we know one that will work! Mesquite and its microbial allies have served as one such "biotechnology" in the region for

over 8,000 years, generating fermented beverages and foods, shelter, and habitable environments. We believe that more knowledge transfer, use, and innovative management of mesquite and its many products could generate multiple revenue streams without depleting key natural resources.

We are calling for greater investment in innovations that will move us toward managing mesquites and restoring certain of their habitats known as "nurse plant guilds."

Just how can such investments help us better use the borderland habitats now dominated by the several species of woody legumes in the genus Prosopis *commonly called mesquite?*

To be effective, these investments must be focused on assisting economically impoverished communities of Indigenous and immigrant populations so that they do not become "climate refugees." They must also act upon the consensus among range managers and foresters that mesquites are "under-managed" on nearly 200-million acres of arid and semi-arid lands in Mexico and the US.

Can targeted investments change that dynamic?

Yes, we believe they can, because mesquite resources can become—dollar for dollar and peso for peso—the most cost-effective natural and cultural resource investment ever made for the future of Arid America. Such an investment cannot come too soon because our metro areas are suffering from urban heat island effects on top of global climate change.

How exactly will such exacerbated heat conditions affect us?

The degraded watersheds and foodsheds surrounding those who work outdoors in and around our cities make them increasingly vulnerable to many heat-related maladies, diseases of oxidative stress, and lost work time due to stress and illness.

Disparities in income and access to resources are already the triggers of social conflicts, violence and immigration issues that clearly affect citizens in both Mexico and the United States.

FORECASTING TRENDS

The best predictions of what vegetation changes will occur in the borderlands over the next century suggest that mesquite woodlands will become more extensive, with higher densities per stand or grove. Irrigation water from rivers will become scarce and the costs of pumping fossil groundwater from wells will rise. This is why agronomists suggest that alley-cropping heat- and drought-vulnerable field crops between shade-bearing rows of mesquite will become increasingly viable economically.

Does that suggest that they could also become more economically important?

Yes, provided their habitats are properly restored and managed, for two of the three species of mesquites will increase their rates of woody growth, pod production, and carbon sequestration.

Mesquite root systems can fix nitrogen and sequester carbon more effectively than most arid-adapted trees and shrubs. And there are emerging markets that might pay ranchers and farmers for more precisely managing their mesquite-covered rangelands, pastures, hedgerows, woodlots, and agroforestry plots.

Is the shade and forage mesquite provides for wildlife and livestock on rangelands truly significant?

Yes, it is, and at the same time, mesquite can provide much-needed shade and foodstuffs for metro residents dwelling in urban heat islands. In many border counties, range-fed cattle, sheep, and goats can no longer survive on native grasses alone; mesquite's foliage and pods have become the default feedstock for livestock from late February through July, and its shady canopies have become daytime sanctuaries for both livestock and wildlife. A growing number of ranchers who used to grub out mesquite trees now concede that mesquite provides nutritious food and shelter essential to the survival of their herds and flocks.

Then why don't more ranchers acknowledge that mesquite is likely their best and most cost-effective livestock feed on Western and Mexican rangelands below 5,000 feet (1,524 meters) for at least a third of each year?

Rather than quibbling over who is right, we need to encourage the most innovative ranchers to use "mesquite-and-perennial-grass banks" during particularly critical times when prolonged droughts make all annual forages scarce. Such scarcity will become more severe and frequent as climate change accelerates. In fact, many stockmen have already begun to manage their ranches making use of mesquite as a habitat for wildlife as well as for livestock. Others harvest and grind pods for silage.

Is it a stretch for them to also manage their land for mesquite honey, pods, woodworking, and fuelwood production as well?

Not at all. Most ranchers would readily welcome public investment that would help them generate multiple revenue streams (from food, fuel, wood, hunting, hiking, and birding) to gain more income from their mesquite resources.

Mesquite-based rural training centers foster community development through workshops led by master artisans.

REQUISITES

Such intensive land management requires a stable rural labor force, one that northern Mexico and the US have largely lost since the signing of NAFTA in 1992.

How do we now grapple with recent changes in immigration and trade policies that have further reduced and debilitated the transboundary work force?

For starters, we need to promote training and other benefits for those who wish to participate in a well-managed guest worker program that complements rather than competes with the working citizens already living in the region. We advocate for an expanded guest worker program to guarantee Mexican citizens wishing to work in the US greater legal safety, health benefits, job training, and upward mobility.

Haven't such programs historically focused on harvesters of agricultural crops, not on managers, harvesters, and processors of wild trees?

Not exactly. Guest worker programs have always included opportunities for ranch hands, woodcutters, and artisans in rural communities. We propose greater public and private investment in infrastructure to harvest, mill, dry, store, and elaborate value-added products from both mesquite wood and its edible pods and honey.

Shouldn't such investments be made principally in counties and municipios stretching along the border where mesquite is abundant but other jobs have been lost?

Absolutely, but not exclusively. They should also focus on those Native American communities near the border that have long-standing familiarity and traditional ecological knowledge of mesquite resources. We propose the establishment of at least 12 capacity-building centers for mesquite artisans located in every watershed crossing the border.

Could these centers easily provide bilingual rather than English-only training in a variety of skills related to arid lands agroforestry and non-timber forest product development?

Definitely, for there are many bilingual teachers and trainers who already have the capacity to mentor others in range management, ecological restoration, permaculture, hardwood craftsmanship, and furniture making, honeybee management, mesquite pod milling, brewing and baking, and the marketing of non-timber forest products. Training certificates should be bilingual and help artisans obtain jobs on either side of the border.

A workshop on mesquite propagation offers participants the chance to learn about getting started growing mesquite.

CURRENT USES AND OPPORTUNITIES

There is speculative value—in terms of carbon bonds and ecological sustainability—of atmospheric carbon sequestration that results from proper forest management. But there is already tangible value in a US$ 200–400 million per year "mesquite barbecue" industry that uses trees harvested from rangelands in the US Southwest.

Isn't the market saturated if this industry already provides firewood, briquettes, and chunk charcoal to over 8,000 barbecue restaurants and other outlets located in all 50 American states?

Not necessarily. As other woody trees are impacted by climate change, mesquite's proportion of the market is predicted to grow. Nonetheless, the retail value of custom-designed mesquite furniture, parquet flooring, paneling, musical instruments, and fencing for larger pieces of wood is many times more than that of the same wood burned as charcoal or kindling.

How do we encourage more woodcutters to select and sustainably harvest their mesquite for higher value markets?

They will need to be informed that carefully dried, straight mesquite lumber will soon be selling for US$ 5–15 (MX$ 100.8–302.5) per board foot (BF), and to be put in touch with those eager to purchase such hardwoods. Some mesquite continues to be clear-cut and killed when in the way of transportation routes or utility lines, so we should first make use of the wood salvaged from those trees. Most mesquites cut down on rangelands retain some resprouting capacity that generates multi-stemmed trees with lower-value wood, but that can be better pruned both for livestock and for product harvests.

How do we change entrenched practices and attitudes?

As with any other forestry resource, we need to explicitly train harvesters in cost-effective selection, coppicing, and pruning practices. We then need to shift the industry toward better uses to prime pieces of lumber for their elaboration of value-added products. We also need to shift USDA Forest Service priorities from near-exclusive focus on temperate trees to include desert trees.

Fortunately, or not, the cost of every other commercially marketed hardwood has risen exponentially since the pandemic, so that purchasing high-quality mesquite lumber has become more viable. There is also expanding use of mesquite pod flour in baking, in brewing, and in the elaboration of low-glycemic (anti-diabetic) food products.

How do we ensure that demand for mesquite flour—which is currently sold for US$ 12–24 (MX$ 240.51–$481.02) dollars/pound—continues to expand beyond niche markets on both sides of the border?

Greater public and private investment in infrastructure will benefit borderland communities.

We need to better promote the food safety, unique nutritional qualities and flavors of the dozens of new foods and beverages that are trying to get a foothold in the global marketplace for so-called "superfoods" or nutraceuticals. Until mechanized harvesting equipment becomes available, hand-harvesting and processing of mesquite pods remains time-intensive and costly. With greater supply, prices will lower to make mesquite flour affordable to all.

How do we encourage agricultural engineers to develop more scale-appropriate milling equipment, cold storage protocols for mesquite flour, and rapid food-safety monitoring techniques needed today?

We need to lobby the deans and department chairs of agricultural land-grant universities to think of mesquite as something other than a rangeland nuisance, and earmark funds for mesquite research and development positions in several disciplines. But we also need to remind decision-makers that mesquite honey and lumber are already multi-million-dollar industries in most states along the border. Other regions in the US and Mexico gain far more investment in the management of native hardwoods and their non-timber forest products than border states in desert regions do.

What has the arrival of Africanized honeybees and the greater frequency of severe droughts done to create problems for beekeepers and mesquite managers?

Over the last two decades, beekeepers have found safe ways to competently manage and tame "hybridized Africanized" bees and to utilize their skills as efficient foragers and producers of honey. Caution is required, but we need to revisit local laws that ban the keeping of bees in urban areas and near rural schools, while still ensuring student safety.

Mesquite catkin blooms attract numerous pollinating insects, including bees that produce mesquite honey.

Honeybees are not the only pollinating insects attracted to mesquite flowers. Dense clusters of mesquite trees nourish as many as 75 species of native bees in any rural landscapes. Especially important are the gnat-sized bee genus *Perdita*, one of 600 species in the US Mexico borderlands. These, along with *Centris, Megachile* and other native bees, as well as wasps, are efficient pollinators of mesquite flowers.

So how can mesquite blossoms or catkins become a more abundant resource magnet for many insects, including beetles, butterflies, wasps, and flies?

Planting mesquite windbreaks and "pollinator-attracting" hedgerows on farms and orchards in the border states is one way. There are funds for developing and maintaining such "pollinator habitat" through both governmental agencies and philanthropic foundations. We need to help farmers and ranchers apply for such funding and measure the return on investment (ROI) from mesquite plantings.

How do we keep the economic potential and sustainability of such products from being underexplored and scarcely valued by today's impact investors?

Remind investors of the potential for multiple revenue streams: fuels, biochar, gums, propolis, meads, distillates, nutraceuticals, and medicinal products, all of which can be derived from mesquite.

Mesquite offers economic uses and intangible values, and uses less water than conventional crops.

We need to bring mesquite's promise into discussion with the growing number of wealthy young entrepreneurs involved in "slow money" strategies to enhance the environmental stability and solve border poverty issues while producing healthy foods for the marketplace.

PROSPECTS FOR INCOME GENERATION

In short, there are many economic uses and intangible values provided by mesquite and the nurse plant guilds they shape. They draw down considerable carbon for sequestration, especially when alley-cropped with agaves and prickly pear, so that these three desert plant resources can be processed into a nutritious silage for sheep, goats, and cattle. They use less water than conventional crops.

It is time to urge regional planners, natural resource agencies, and investors to assess comprehensively the societal value of the many "ecosystem services" that mesquite habitats provide. These nature's services include wildlife habitat for beneficial insects, birds, and bats involved in pollination and pest control; flood control; heat amelioration in urban settings; and recreational pursuits such as bird-watching and the hunting of game birds like quail and doves.

We encourage significant investments in holistically managing, conserving, restoring, or reconfiguring extensive corridors of mesquite habitats. The level of investment should become commensurate with the overall economic value of mesquite.

Mesquite honey is a richly flavored varietal that can be enjoyed in beverages, baking, and other food applications.


PURE
HONEY
VERDE RIVER
MESQUITE
2018 NET WT. 10 oz.

CHAPTER ONE

Getting to Know Mesquite's Key Features & Values

Probably no other plant has played such a vital role in the ecologies, and among human populations, of the arid and semi-arid regions of Mexico and the US as the multifunctional mesquite tree. This extremely resilient and adaptable tree has a rich ethnobotanical history and holds great potential to become a major staple food crop for drylands throughout the world, while supporting climate change mitigation efforts and providing food security in the face of desertification, water stress, and climatic instability.

Mesquite is a nitrogen-fixing member of the legume family in the genus *Prosopis*. This genus is distributed mainly throughout the Americas with a few species from Africa, the Middle East, and the Indian subcontinent. When we talk about mesquite, we refer to any of the species of the genus *Prosopis* that are native to the drylands of the United States and Mexico.

In the US Southwest and Northern Mexico, at least six species of mesquite play a major role in the ecology and economy of semi-arid and arid landscapes. In this publication, we will focus on the Honey Mesquite (*Prosopis glandulosa*) and the Velvet Mesquite (*Prosopis velutina*), although many of the same features are shared with other species. Currently, 45 distinct mesquite species of spiny trees and shrubs with *bi-pinnate* (compound) leaves are found growing in desertic, semi-arid subtropical, and tropical regions of the Americas, Africa, Western Asia, and South Asia.

All of these species belong to the genus *Prosopis,* which is in the family of legumes known as Fabaceae. Many of them also share certain characteristics with their Old World analog, variously known as carob, locust, *algarroba*, or St. John's bread. Yet, at another level, mesquites are not merely plant species, but *holobionts*, a collective term for a host organism and the variety of other species that live on, near, or within it, jointly forming an ecological unit. From germination of their seeds until well after their decomposition, they host hundreds of nitrogen-fixing rhizobia and Brady rhizobia, as well as vascular arbuscular mycorrhizal (VAM) fungi. In addition to at least 5 kinds of bacteria growing on their roots (rhizosphere), another 21 species have been found growing as *endophytes* inside with trunk, shoot, leaf, or floral tissues (endosphere). These beneficial microbes help mesquites resist heavy metals and tolerate alkaline soils.

Most of the mesquite species in the Americas are nitrogen-fixing, rapidly growing, deep-rooted trees and shrubs that drop their leaves in winter or during extreme droughts. They can be multi-stemmed or single-trunked, with an abundance of large, puncturing thorns, or a paucity of them. Mesquite trees can grow to be 15–60 feet (5–20 meters) tall, and 15–45 feet (5–15 meters) in crown diameter; as shrubs their height reaches 3–9 feet tall (1–3 meters) with dozens of stems in a round crown creating a sandy hummock; they can sprawl for 60 feet (20 meters) in width.

Mesquite has deep tap roots that are needed in drier environments – these roots pump as well as leak moisture and nutrients into the soil shared with other plants.

They typically produce hundreds or thousands of fragrant nectar-rich flowers during the warm season, which may mature into carbohydrate-rich pods once or twice per year. Famously, the roots of one honey mesquite were found lining a mine shaft 160 feet (53 meters) below the soil surface. Their root structure is comprised of shallow surface roots, useful in areas with more precipitation, and deep tap roots required in drier environments. All the deeper roots pump as well as leak moisture and nutrients into the soils shared with other plants that grow under their canopies. As such they are known as nurse plants, *nodrizas* or *madrinas*. The older mesquite trees form "islands of fertility" below their canopies.

These characteristics have been regarded as extremely valuable by both Indigenous and immigrant peoples dwelling in *American deserta*. They offer world-renowned honeys, fine hardwood, slow-burning fuelwood, sweet edible pods, bee forage, liquid smoke, wines, beers, distilled spirits, fine pastry flour, and legume meal, fiber for rope and cordage, and traditional medicines from the gum, roots, leaves and trunk of the trees. They form wind- breaks and hedgerows that attract wildlife and slow erosion. They sequester carbon. They stabilize dunes and creekbanks. They offer nutritious forage to wildlife and livestock. They have architectural grace when properly integrated into home gardens or public spaces. And their many names in various languages have become place names that dot the landscapes of the Americas, reinforcing a local sense of place.

We have seen mesquites extend well beyond the true deserts of western North America, into the highlands and valleys of central Mexico to the south; eastward to Louisiana, east Texas and Tamau-

lipas; north to Nevada, Utah, Colorado, and Kansas; and westward to the coasts of Alta and Baja California. Some ecotypes tolerate wildfires, light to moderate frost, and extended drought, while others do not. They can flower and successfully fruit in temperatures exceeding 120° F (49° C). Although various mesquites do well in most soil types, some populations are salt-tolerant while others are not.

The term *mesquite bosque* generally means any kind of woodland dominated by *Prosopis*, but it more specifically refers to closed-canopy, highly shared tall riparian woodlands along running rivers, old oxbows, and springs. On slopes and plains above floodplains, most mesquites take on a shorter, shrubbier form, with canopies rarely reaching above 30 feet (10 meters) and roots hardly ever diving below 45 feet (15 meters).

In planted groves or agroforestry mesquites grow rapidly on drip or flood irrigation. Although rather healthy as a wild plant, cultivated mesquites can be infected by a number of pathogens, including slime flux bacteria that infects its sapwood, *ganoderma* root rot, as well as spongy yellow heart rot. Pathologists in California believe that infections may be prevented by avoiding wounds to roots and to the trunk at the soil level. In addition, damage to mesquite pods from bruchid beetles is widespread and common, but seldom eliminates all later seed germination.

Mesquite groves harbor an abundance of bees, beetles, and ants, in addition to dozens of perching birds such as phainopepla, which disperse mistletoe seed from tree to tree. Its use as habitat by reptiles and small mammals is also high. Mesquites are enormously beneficial as nurse plants in creating wildlife microhabitats that are also optimal for the growth of dozens of other plant species.

Humans have lived in mesquite habitats and subsisted off its many gifts for upwards of 8,500 years, as have many wildlife species. It's time we give back to this tree.

The nectar supplied by mesquites nourishes butterflies as well as honeybees.

CHAPTER TWO

A Woodcutters' Guide to Selecting Trees, Cutting, and Drying Mesquite Hardwood for Multiple Purposes

PROSPECTS FOR INCOME GENERATION

Aside from the high-end professions for fine woodworkers, there are other sources of employment related to the acquisition and use of mesquite wood: for firewood, especially for supplying barbecues with fuelwood for smoking and grilling; tree thinning, for fire-risk-reduction employment by state and federal agencies; and tree removal near houses, public buildings, recreation facilities, and road expansions.

There are few sources of data in Mexico or the US for the number of mesquite woodcutters or their annual salaries. However, by 2022, mesquite firewood cutters garnered an average annual pay of US$ 26,748 US (MX$ 534,514), with a range from US$ 18,280 (MX$ 365,153) to US$ 41,780 (MX$ 834,528), depending on local market prices and accessibility.

While a full cord (128 cubic feet; 3.62 cubic meters) of stacked mesquite firewood dried for six months now costs anywhere from US$ 350–1,500 (MX$ 6,994–29,974) delivered, there is no single cost estimate of how much time and fuel it takes to harvest a cord of Velvet Mesquite or Honey Mesquite. The market for mesquite firewood for barbecue businesses in the US has never been better. By January 2022, as barbecue joints proliferated in most border states, the demand for mesquite for smoking and grilling meats has risen. At the same time, affordable, credible firewood suppliers have become increasingly scarce.

While many men and women begin an independent mesquite firewood business with just a chainsaw and a pickup truck, other costs arise with business expansion. It is well-known that mesquite wood is hard enough that it dulls chainsaw blades and increases the frequency of purchasing replacement blades, chains, and chainsaws overall. Mesquite often grows on rugged terrain so that access by pickup truck and miles to delivery vary greatly. In addition to chainsaws, there are several other implements that need to be purchased as a competitive firewood business matures and expands: splitters, cleaners, haulers, stackers, and conveyors, as well as solar driers, some of which we will discuss below.

Mesquite firewood cutting has relatively low entry costs compared to other rural professions. Not all wood, however, is "free for the

taking"—on private ranches, a fee must be negotiated with the property owner, and on public lands with the appropriate agency. In some states, such as Arizona, there is also a fee for transporting wood for personal use, salvaging wood from designated areas, or harvesting wood as a commercial business. In USDA Forest Service districts in the border states, there are several different kinds of woodcutting permits, each with a different cost and quota.

- **Personal-Use Paid Permits** allow the cutting of downed and dead wood or standing dead wood that meets certain criteria in specified areas at a cost of US$ 10 (MX$ 200) per cord for mesquite, oak, juniper, and maple; or US$ 5 per (MX$ 100) cord for soft woods such as pine, aspen, and mixed conifer. The minimum purchase allowed is US$ 20 (MX$ 400) , and 12 cords per household per year is the maximum quantity allowed.
- **Free-Use Permits** allow the cutting of up to 5 cords of downed and dead wood in specified areas for no charge. A maximum of 5 cords per household per year is allowed under free use. There aren't always free-use firewood areas designated, so you will need to check with a Ranger Station to see if one currently exists.
- **Ceremonial Permits** allow tribal members to collect ceremonial and medicinal plants for free. Tribal members should contact their Tribal Liaison for more information.
- **Commercial Permits** are for collecting firewood to sell in a commercial capacity for profit. Personal-Use Paid Permits are not allowed to be used to collect firewood to sell to someone else. Contact the Ranger Station of the district you're inquiring about for information about any commercial areas that may exist.
- **Green Wood Permits** are occasionally offered. Information can be obtained on these occasional sales by calling the respective Ranger Station.

As the dentist says, ignore your teeth and they will go away. The same can be said for mesquite: they need occasional care, pruning, and thinning or they become a problem species.

PRUNING, POLLARDING, AND COPPICING FOR SUSTAINABLE PRODUCTION

In many ways, the inherent resilience of mesquite species in the US and Mexico is among the reasons they are well-suited to vegetative regeneration, periodic harvesting by *pruning, coppicing,* or *pollarding* for sustainable management. When the largest trunk of a mesquite is cut, it disrupts what is called *apical dominance* and hormonally stimulates the physiological process of lateral shoot generation. Many ranchers who thought they had clear-cut mesquites off their rangelands have been rudely awakened by the proliferation of side stems, shoots, suckers, or "water sprouts", off the cut trunk in the following three years or more! This capacity for regenerating lateral stems or side shoots can be managed for

periodic harvest of mesquite for latticed fencing material, fenceposts, ramada uprights and horizontal beams, as well as cordwood.

The simplest definition of *coppicing* is to periodically cut back a tree or shrub to ground level to stimulate growth. More specifically, *coppicing* is a traditional method of woodland management that exploits the capacity of many species of trees to put out new shoots from their stumps or base of their multiple trunks. In a coppiced woodland, one called a *copse*, mature tree stems are repeatedly cut down to near ground level, resulting in a stump called a *stool.* As several years of new growth emerge and thicken, the coppiced tree is harvested, and the cycle can begin anew. *Pollarding* is a similar process, but the pruning is done at a higher level on the mesquite's trunk to discourage grazing animals from eating the new shoots.

Because mesquite shoots emerge from the stool or pollarded trunk in such great numbers, it is wise to prune two-thirds to three-quarters of the new stems each year, so that the others thicken and grow taller at a faster pace. The pruned stems can be used for lattice fences, for making mulch after putting branches through a chipper-shredder, or for shaping water harvesting catchments below the tree's crown. There does not need to be any "waste" if the repurposing of the pruned wood is carefully thought out and implemented in the weeks following the pruning.

Overall, many ranchers and property owners prefer 1– or few (3–5) trunked mesquites with umbrella-like canopies and few suckers or lower branches. It may take several years to achieve, but densities of taller, few-trunked mesquite trees every 30 feet (10 meters) or 100 trees per hectare (2.47 acres) is ideal for most uses of mesquite: wildlife and livestock habitat, pod collection, honey production, and periodic harvesting for fine hardwoods or fuelwood. Passively or poorly managed mesquite woodlands in borderlands states may currently harbor 900–1,000 multi-stemmed mesquites per hectare (2.47 acres). That suggests that we have a long way to go in learning to better manage mesquite habitats.

Pruning done at higher levels on a mesquite's trunk discourages grazing animals from eating the new shoots.

CHAPTER THREE

An Artisans' and Woodworkers' Guide to Selecting, Drying, and Finishing Mesquite Hardwood for Value-Added Products

PROSPECTS FOR INCOME GENERATION

Of the many economic values of mesquite, the most lucrative is that of using the lumber cut from its trunks to make value-added products such as elaborate custom furniture, wooden instruments, and utensils. The unique features of this hardwood allow artisans to showcase their creativity as they craft these products.

By 2021, there were nearly 250,000 US citizens employed as woodworkers, making an average of US$ 17.65 an hour for their work, or US$ 36,710 a year. The top 10% who are usually fine woodworkers, make an average of US$ 147,000 a year. In Mexico, there are nearly 300,000 woodworkers, who by 2020 made anywhere from MX$ 70,000 - $91,000 per year (or 30–40 pesos per hour). The higher-paid fine woodworkers made MX$ 180,000 per year. A tenth of woodworkers in Mexico are of Indigenous descent and less than 2% of them are women.

Despite variations from year to year, by 2019, 8.3 billion board feet (BF) of new hardwood lumber production was annually entering the US supply stream. About a third of that—338 million BF—was from hardwood supplies from Western US production, including mesquite.

While Western US production was gradually sliding down from 2012 to 2018, the supply chain problems that emerged during the pandemic have caused both greater demand and higher prices per board foot. By late 2021, demand for nearly all categories of lumber was spiking, but supplies were scarce. Contracts for the delivery of future lumber supplies hit $1,733 per 1,000 BF in late 2021, up 400% from the year before—the fastest rise since the housing boom following World War II. Since then, global prices and supplies for lumber have been wildly fluctuating, but locally sourced mesquite prices continue to rise.

By June 2022, the Woodworker's Sources quote mesquite 4 x 4 boards are going for $19.99 per board foot if fewer than 100 BF were ordered, and $14.99 if 100 or more BF were ordered. Today, mesquite can garner higher prices than oak, maple, and ash.

ACQUIRING SIZEABLE MESQUITE HARDWOOD FOR WOODWORKING

To obtain dried, straight, quality hardwood for woodworkers, larger, older living trees should be carefully pruned or *coppiced*; alternatively, one can seek out dead trunks salvaged from floods, road construction, legal land clearing, or lightning strikes. If possible, avoid taking larger live mesquite from riparian corridors, which are important as habitat for migratory wildlife. Some cities, counties, and states have hotlines or websites that provide information on construction sites or corridors where the salvage of the mesquite wood is not only permissible but welcomed. It's important to check whether your state requires permits and tags to move loads of native trees, plants, or wood on public roads.

In addition to mesquite wood harvested from the wild, most species respond well to cultivation using the principles and practices of arid-land forestry management to sustain production of wood and other resources over decades.

It is unlikely that woodcutting alone could endanger any of the three to five species of mesquite grown naturally in the desertscrub (*monte*) of 55 million acres (22.26 million hectares) of the semi-arid and arid lands in the US Southwest and adjacent Mexico; however, the tall, dense closed-canopy bosque habitats of floodplains have precipitously declined because of groundwater depletion, damming, and woodcutting. Wise woodcutters have learned not to "kill" any mesquites of exceptional stature, but instead carefully manage them by *coppicing* or *pollarding* for longer-term yields of quality wood.

Although the unacquainted may think of mesquite as more of a spindly, invasive shrub only good for firewood, rather than a tree with the potential to render diverse forest products, mesquites growing on floodplains often reach heights of 10 yards (9.14 meters) or more and rooting depths of 50 yards (45.72 meters) have been recorded. Trunks may accrue girths or diameters of 1 yard to 4 feet (0.91 to 1.2 meters). In agroforestry plantings—with or without supplemental (drip) irrigation—mesquite trunk diameters can thicken 3/5-inch (1.52 centimeters) per year, reaching 18- to 20-inch (45- to 50-centimeter) diameters in less than a quarter century.

In their natural habitats, mesquites are often accompanied by other arid-adapted legume tree species, including desert ironwood, palo verde, acacia, *guamúchil*, *guaje*, and feather tree. You can always tell which tree legumes are mesquite by their chocolate-colored, furrowed, and scaly, almost shady bark with stains of black gums near wounds, bark, and wide, spreading or arching canopies. Their lateral branches can be long, arched or twisted and long, and the straighter branches or suckers sprouting from the base of the trunks are thin and willowy. Sharp thorns are present on 95% of the individuals of most mesquite species, but thornless

varieties can easily be selected by recurrent selection through air-layering propagation.

Whatever mesquite wood you salvage or acquire from others, it is best to work when it has stabilized to a dry condition, to avoid unnecessary cracking, splitting, or shrinkage.

QUALITIES OF MESQUITE HARDWOODS

The highly valued hardwood of mesquite has many unique qualities to its credit. The Texas Forest Service has determined that honey mesquite lumber was superior to six other woods, such as oak and hickory from arid, semi-arid and subtropical parts of the US/Mexico border states in every quality category except bending strength. The honey mesquite was rated the best or lowest in volumetric shrinkage, about one-fourth that of the other six woods. The low shrinkage rates of mesquite wood volumes are desirable if the shrinkage remains uniform within the wood. In addition, its radial and tangential shrinkage rates are almost equal, a quality which reduces stress on the wood during periods of high moisture buildup, as occurs with seasonal weather changes. No other wood compared during the shrinkage tests exhibited these same properties.

Properly dried honey mesquite weighs about 4 pounds per board foot, its hardness rating on the Janka Hardness Scale is 2,229 (78% harder than most red oak), but its specific gravity is about the same as red oak (0.64). Many fine woodworkers find it ruggedly handsome, a bit more difficult to work because of its hardness, but surprising and satisfying in the mélange of knots, splits, work holes and bark pockets it offers. The heartwood of mesquite has a grain that is medium to coarse in texture, and tightly interlocked. It can express itself in wood products as moderately straight to wavy and swirled (especially in burls).

Remarkably, the colors in a single board, burl, or disc can vary in color from dark brown with wavy, blackish lines to camel tan and luminously yellow. The grain is straight to wavy, medium to coarse in texture, and tightly interlocked. The freshly cut heartwood is often a lighter, yellow, but it mellows with age and exposure to light into dark red and chocolate brown hues. Incidentally, the fresher, wetter sapwood is generally much more susceptible to attack from insects and can be quickly degraded. If properly dried, it easily works up into useable planks, cores, or burls for sculptures or for furniture, all of which express a luminous finish.

The heartwood of most mesquite species can be extremely dense, strong, and durable. The wood density of most mesquite species is in the range 700-1,200kg/m^3, with a specific gravity of wood of 0.7–1.0. It typically has more tensile strength than most oaks and is nearly 1.75 times as hard as teak.

The value of mesquite hardwoods is not in their uniformity and homogeneity, but in their heterogeneity. They offer a rainbow of colors, shapes, and textures to the open-minded artisan.

Nevertheless, mesquite wood has some drawbacks: high variations in its density and bending strength. These qualities result in more than a 300% variation in the volumetric trait of the wood. Nevertheless, honey mesquite heartwood shrinkage remains lower than any other wood in the US/Mexico border states, with the exception of desert ironwood. To avoid problems resulting from shrinkage, mesquite must be properly dried and stabilized to the ambient conditions of where it will be installed if it is to remain suitable for high-quality furniture that withstands cracking or shrinking. Mesquite wood imported from wetter subtropical climates does not weather well as furniture under drier conditions. Ideally, you should work only with wood dried to a maximum moisture content of 6–7%. Mesquite wood for coarser outdoor furniture like picnic tables can endure years at a moisture content of 12%.

Fine woodworkers are fascinated by the variety of aesthetically interesting features.

If you can afford the tools to take the raw materials to the next level, finely processed mesquite wood is well-suited to the elaboration of value-added products by using mills, lathes, or edge banders into sizable pieces of finished timber, or into circular and cylindrical profiles. The specific wood color, grain and shape of each mesquite tree must be selected for a good fit with a particular purpose.

The straight portions of mesquite trunks are typically short: 2 to 4 yards (1.8 to 3.7 meters). They may be voluptuously curved or twisted for any longer height or length. Most of the stoutest branches of each tree fail to attain diameters of 1 foot (0.3 meters) or more. This makes mesquite a poor choice for long, straight planks, poles, or boards, although slightly curving upright posts and horizontal beams for ramadas and other outdoor shade shelters are often cut in 10- to 14-foot (3- to 4.3-meter) lengths.

What fascinates most fine woodworkers is how mesquite offers a variety of aesthetically interesting features such as bark hollows, radial cracks, ring shakes, and irregularly wavering or swirling grain patterns with boldly contrasting colors. Because of their tortuously twisted trunks, survival of damage by lightning strikes and mistletoe infestations, bird-excavated knot holes, partially buried crooked limbs and bases, broadly sprawling crotches and wildly erupting suckers, there is incredible variation in wood from one tree to the next.

With today's availability of clear-casting resins and polyurethane-sawdust mixes, a good craftsman can fill holes, breaks and cracks, sanding and contouring them so that they do not appear artificial or lifeless. Again, if slowly and properly cured in a solar-drier, mesquite wood is regarded among the most dimensionally stable of all woods. Mesquite drawers seldom stick in cabinet frames with changes in humidity!

METHODS FOR MILLING AND MACHINING

Combined with its interlocking grain, the very hardness or tensile strength of mesquite can make it vulnerable to chipping or tear-out during milling, planing, drilling, and joining. That's why most mesquite woodworkers typically predrill mesquite for nails and screws. They have developed other strategies to deal with mesquite's hardness and density, such as those below.

First, be sure to employ only spurred bits and slower drill-press speeds for mesquite. Always feed the mesquite wood into the saw at a slight angle and take light passes while planing, so that you only remove about 1/32-inch (0.76 mm) at a pass. Secondly, when ripping a plank, gradually feed the mesquite wood against the blade, allowing the gullets plenty of time to clear themselves of sawdust.

Elias Samorano of Sierra Madre Mesquite, Tubac, Arizona.

Next, adjusting the grain direction when feeding a plank through the jointer should not generate any major problems, but slight chipping may still occur. You can remedy this by initially setting the table height for a 1/16-inch (1.6-mm), and should there be no tear out, adjusting the cut up to 1/8-inch (3.17-mm).

To further reduce the frequency of problems, clear bits frequently in thicker stock to keep from burnishing the hole sides. You can also reduce tear out and chipping when routing by shallow passes rather than deeper ones, and by keeping to a steady feed rate. It's helpful to employ a backing board or stout stick to rout the end grain.

Here are some tips regarding finishing. Sanding across the grain of mesquite may scratch the surface. But at the juncture where grains meet at right angles, you can finish them cleanly with a cabinet scraper or random-orbit sander. When applying glue to mesquite wood, it is best to use adhesives with longer open (drying) times. This enables you to initially apply a light coat of glue, then briefly join the pieces to test fit. You may still be able to pull them apart and let the adhesive partially set up before firming up the fit for the ultimate joining.

Finally, the qualities of properly dried mesquite wood seldom cause problems for staining or sealing. You will find it best to use only light seal or penetrating oil that allows the luster and grain patterns of the heartwood to be highlighted and not obscured.

Guidelines for Milling and Machining

- Feed straight-grained wood into planer knives at a 90° angle. To avoid tearing, feed figured wood or that with interlocking grain at a slight angle of 15° and take shallow cuts of about 1/32-inch (0.76-mm).
- Rip with a rip-profile blade that has 24–32 teeth to achieve the cleanest cuts.
- When crosscutting, use 1-inch or 12-inch blades with at least 40 teeth.
- At all costs, refrain from using twist drills. They are apt to wander from the start hole, risking breakout.
- Rout with sharp, carbide-tipped bits by taking shallow passes to avoid burning.
- Predrill pilot holes for screws, nails, pegs, and bolts for joining.

A finely-crafted finger piano by wood artisan Zach Farley.

METHODS FOR CARVING AND TURNING

Unlike the woods of so many other trees, mesquite can be carved when fresh and green because it checks very little as it dries. Nevertheless, you may need to start the sculpting with power-carving burs to remove unwanted material without resulting in much tear out. Carving mesquite heartwood generally requires shallow gouge bevels, 15° to 20°, and shallow cuts. For turning mesquite with lathes or other tools, keep them extremely sharp by regularly honing them, and avoid scratches by sanding with the grain after the lathe has been turned off. From there, it's all in your skill and imagination!

A historical tortilla press made from mesquite wood, along with a chiltepin grinder. (Courtesy of Loma Griffith)

CHAPTER FOUR

Harvesting and Milling Mesquite Pods for Food and Beverage Use

PROSPECTS FOR INCOME GENERATION

The highly nutritious and sweet pods of the mesquite have been one of the most important staple foods of the native peoples of the Americas for thousands of years before the introduction of corn. The oldest archaeological evidence of the use of mesquite as food dates from 6,500 BCE from the Tehuacan Valley in Puebla, Mexico.

Today renewed interest in the desirability of mesquite as a food source is drawing attention in the food industry. Somewhere in the US or Mexico, every day, someone is sipping a mesquite-dusted cappuccino, a pink mesquite lemonade, a mesquite beer, a mesquite wine or mezcal, or eating a cracker, cookie, bread, or biscotti made with mesquite. As Barton Mills owner James A. Brown has told the press, mesquite has "sweet complexity that's very appealing and hard to tack down."

Within the last two decades, mesquite flour and powder (finely ground, like pastry flour) have shifted their status from "forgotten foods" that were vestiges of historic Native American foodways to award-winning value-added products. A quarter century ago, there was only one mesquite flour product commercially available in the US and Mexico. It was the half-pound bag of the Pro-Mez flour developed by Friends of Pro-Natura in the Arizona-Sonora borderlands, with flour from mesquite pioneer Ivan Aguirre. The products used pods harvested by Sonoran ranch hands and *Comcaac* (Seri) foragers that were then milled by Ivan on Rancho Inmaculada, one of the first holistic grazing ranches in Mexico

As of August 2022, there were no fewer than 21 brands of mesquite pod flour/powder products available from at least a dozen companies through Amazon.com and Nuts.com, and at least another 6 flour products sold in gift shops and farmers markets in Tucson, Arizona, alone. The price per pound (16 ounces, 454 g) varies widely from US$ 7.75–39.99 (MX$ 154.65–798.01), with most products sold for baking and brewing currently in the US$ 12.00–24.00 (MX$ 240.51–481.02) price range. While these prices are high compared to the cost of wheat, corn, or barley flour, they are in the same range as high-quality pastry flours milled from chestnuts or carob pods.

Name brands now offering mesquite flour include some of the biggest in specialty organic flours, hypoglycemic products, paleo- diet wild foods, and gluten-free flours: Casa de Mesquite,

Dinavedic Premium Foods, Earthtone Organic, Essential Organics, Food for Life, Integrity Foods, Maya's Secret, Nature's Eats, Prescribed for Life, Salud Vida, Terrasoul Superfoods, Vegishake, Yupik Organic Superfoods Z Natural Foods, Zint Raw Foods, and Zocalo.

In Tucson, Arizona, the Desert Harvesters Cooperative has published recipes, held community milling festivals, and promoted mesquite as an urban agroforestry food crop using rainwater harvesting for irrigation. In Austin, Texas, baker Sandeep Gyawali of Miche Breads has initiated the Texas Mesquite Project that uses the Barton Springs Mill for pod processing. The *Comcaac*, or Seri Indians, of coastal Sonora have fire-roasted pods in chile roasters and milled flour for sale for more than 15 years; their fire-roasted Honey Mesquite flour has been boarded onto the Slow Food Ark of Taste.

Pod inspection teams at specialized tables in Mexico.

Mesquite's Food Value

The fruit produced by *Prosopis* species are legume pods that contain, depending on the species, 7–22% protein, 11–35% soluble fiber, and as much as 41% sugar content. Their carbs can be processed without much effect on insulin. Mesquite pods have a low-glycemic index and contain lysine and other essential amino acids. They are also a good source of potassium, manganese, and zinc. Studies done by Richard Felger, of the Drylands Institute, estimate that 1 hectare (2.47 acres) of wild mesquite can yield between 2–10 tons of fresh pods, depending on climate and species.

Not all species of mesquite in North America are suitable for food processing and consumption; the pods on some species, for example, have a high tannin content that gives them an unpleasant flavor. Fortunately, there are several that have great potential because of their desirable taste. The species most utilized as food in North America are *Prosopis laevigata*, *P. velutina*, *P. glandulosa* and *P. pubescens*. Their distribution extends from the US Southwest to Central Valleys in the southern state of Oaxaca in Mexico.

Mesquite flour can have an earthy sweetness, often described as slightly fruity with a hint of caramel, and in some pods a cinnamon/chocolatey flavor and aroma, but it is a fleeting sweetness. Their gummy galactomannan soluble carbohydrates lower blood-glucose levels and increase insulin, so they are considered a "slow release" or hypoglycemic food that can help manage Adult Onset (Type 2) diabetes. Even so, mesquite pods have a high total content (30–50%) of carbohydrates that are slowly converted to sugars. They were traditionally used to make a nearly colorless wine-like alcoholic beverage. The pods don't need to be malted by bakers, and the talc-like fraction from milling is much like carob powder and chestnut pastry flour in its fineness.

Harvesting Mesquite Pods for Food

Most of the harvesting for these products is from truly wild mesquite trees in natural or semi-managed habitats. The late Mark Moody began cultivating mesquite for pod flour and specialty wood products near the Arizona-California border more than a decade ago. In experimental plots of mesquite trees spaced from 1.22 to 6 meters apart (4 to 19.68 feet), Peter Felker and his associates estimated mesquite pod yields on minimum water supplementation regimes of 3,120–4,010 kg per hectare (2.78–3.58 pounds per acre). Such yields are relatively equal to, or above, the food yields of most other minimally irrigated tree crops in North American deserts. Rather than using 6–9 acre-feet (18,285 to 27,430m^3) of water for irrigation as alfalfa does, mesquite groves can use 1–2 acre-feet (3,408 to 6,095m^3) per hectare.

Harvesting and processing mesquite pods (without much addition from the hard-shelled seeds inside!) is far less problematic than doing the same for pecans, walnuts, pawpaw, or persimmons. Newcomers to the desert often seem daunted by the task. Relax! There is no need to get harvester's cramps over joining the profession of *Prosopis* pod pickers and pounders.

The first step when harvesting is to taste-test ripe pods to make sure that they have desirable flavors with little to no undesirable aftertaste. The flavor can vary widely between some species of *Prosopis* and be more uniform in other species, so it's important to become familiar with your local mesquite population. Desirable flavors might include sweet, nutty, caramel, maple, tamarind, and chocolate. Flavors to avoid include chalky, astringent, and bitter.

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When pods ripen in late spring or early summer, they turn color from green to tan/golden, pink or dark purple. Just as with color, there might be important differences in thickness, beading around seeds, and tail size, among others. Pods dry out as they rip- en so seeds rattle inside when shaken, and ripe pods snap when broken. Clusters of ripe pods should come off easily when pulled from the trees.

One of the main health concerns about mesquite processing for food consumption is the presence of aflatoxins from moldy pods infected with *Aspergillus flavus*, which can be invisible sometimes. Avoiding visible mold DOES NOT ensure safe pods. For this reason, it's critically important to harvest the mature pods before the

Pods on the ground can be infected with poisonous aflatoxin and are often infested with insects as seen here with the abundance of small holes.

summer rains, otherwise, exposure to high humidity and heat provide the perfect conditions for the growth of molds. Extra care should be given to this issue in low-elevation regions with warmer temperatures.

Selecting Your Harvest Site

Site selection and preparation is everything. First, avoid harvesting pods adjacent to fields, roadsides, or rangelands that are sprayed with herbicides. Dry washes or ephemeral watercourses not far from parking areas are ideal sites to seek out, since they usually have more productive trees than upland vegetation.

As you see pods begin to ripen from green to a tawny or rosy hue in the spring or summer, begin to choose the gathering grounds where you wish to forage. First, remember where you or others have sampled the sweetest and most flavorful pods in previous years, for all mesquite trees are not equal in taste. Next, look for larger trees with higher densities of pods, so you don't spend all your foraging time walking around looking for the motherlode. When you've selected a site, prune back any broken or dead lower branches of the tree that may get in the way of your reach once you begin the harvest. Be sure not to harvest trees on restricted-use government lands or private lands where such gathering is prohibited

For more than 6,000 years indigenous communities ate mesquite pods, a major slow-release food that helps to control blood-sugar levels. Is it any wonder that an epidemic of diabetes came on the heels of desert communities forsaking mesquite for junk food?

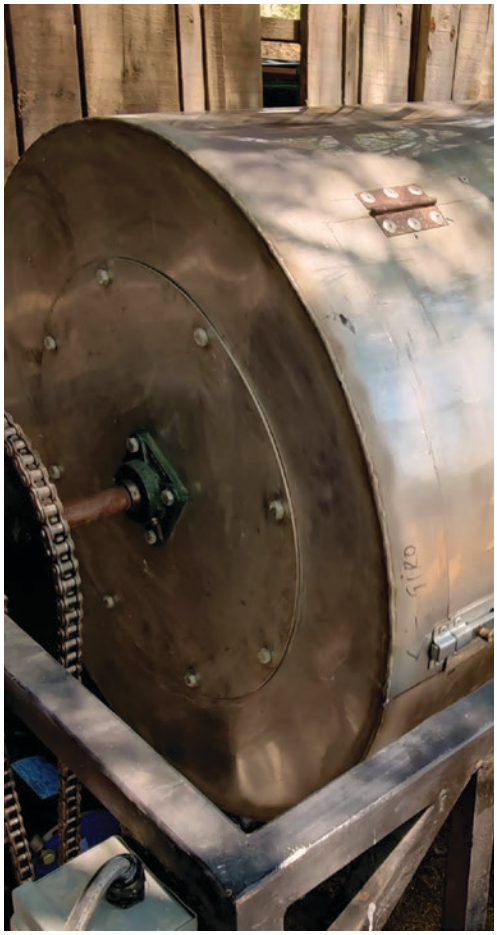
Timing Your Harvest

In the Sonoran Desert, the best time to harvest pods is before the summer monsoons, which typically begin between June 20 and July 10. Frequently check on the pace of pod ripening over the season to schedule your harvesting foray when over half the pods on most trees are so ripe that you can simply brush them and they *dehisce*, or fall, from the branches. They often begin to become mottled with red and exude a sugary syrup onto the surfaces. Freshly tasting a pod or two from each tree before you harvest a lot of pods is the best way to ensure you devote your time to the most flavorful ones available on the site.

As you check the trees in the weeks leading up to this stage, you may put inexpensive tarps out on the ground under the canopies of the best trees, or better, hang from the lowest branches bird nets made to protect fruit trees from feathered foes. In other words, do everything possible to avoid picking any pods up directly off the ground, to maintain the highest food-safety standards. To the extent possible, choose to harvest pods before heavy rains, not after them, when the pods tend to spoil, discolor, and attract fungal spores that lead to aflatoxins or other health risks.

On the day of harvesting, bring along some lightweight baskets or plastic buckets, carefully washed and dried before use. Wear a long-sleeved shirt, gloves and sturdy shoes that repel any thorns in the understory. Some harvesters use small hand-held garden rakes or other implements to brush the pods into buckets or baskets, but you can simply brush them into the baskets with your fingers. Immediately after each brushing, remove leaf stems, twigs, and other debris from your container before adding more pods to it. You may have to clean and sort a second time once you bring the pods out of the field but begin to reduce non-pod litter while you are under the trees.

The Desert Harvesters Cooperative projects that the average harvester can leisurely pick 5 gallons (18.9 liters) of whole pods from a pruned-up mesquite tree (without picking any pods up off the ground) in about 80 minutes. It takes another 15 minutes to lay out to dry, clean, and store the pods for milling. The 5 gallons of whole pods can be ground into about 250 to 300 ounces (7–8.5 kg) of flour, or 3.25–3.75 pounds (1.47–1.75 kg) of edible product.



Propane rotational dryer with an electric motor, designed by Gerardo Ruiz Smith.

Guidelines for Harvesting Mesquite Pods:

- Check the maturation of the pods regularly and harvest as soon as the pods are ripe. Pods are ready to harvest when they are dry, rattle, and pull easily off the trees. Hard pulling indicates that pods are unripe.
- Use clean food-grade polyethylene grain bags, cloth bags, or plastic buckets for harvesting.
- Harvest only pods that look healthy, have no black mold, and have a desirable taste when chewing on them. Pick those that have a sweet flavor with no bitter taste.
- It's highly recommended to only harvest pods straight from the trees. If you harvest from the ground, make sure that the pods feel completely dry/brittle, that there are no potential contaminants–such as stems, flower catkins, dirt clods, livestock feces– and that soil moisture is very low. Harvesting from the floor comes with a much higher risk of mold and aflatoxins. One safe option is to lay down a plastic tarp on the ground before shaking or hitting the branches with a pole to cause the pods to fall over the plastic tarp.
- Avoid harvesting pods immediately after the rains if they are fully ripe. Always look for indications of mold, discoloration, rotting odors, or unusually wet and pliant pods.
- Harvest pods only from areas that are free from toxins and pollution. Do not harvest pods from the sides of high-transit roads or from farmland where agrochemicals might be used.

- Do not wash the pods with water, for the pods will absorb humidity, which creates favorable conditions for mold.
- Sort pods on a metal table for a final inspection. Choose only the healthier pods and discard the rest. Take out any leaves, branches, or other foreign objects.
- Before storing, dry your pods as thoroughly as possible. Avoid storing pods that are not fully dried, as this could cause mold to develop.

Traditional use of a mano and metate for grinding mesquite pods into flour.

Drying Mesquite Pods

The drying process is a critical step in the production of high-quality mesquite flour. Because of the high sugar content in the pods, they are *hygroscopic*, meaning they readily take up and retain moisture. Dry and brittle pods are key to successful milling. Storing wet pods not only increases the chance of mold growth, but the hatching and reproduction of bruchid beetles and Indian moths, as well.

After harvesting, lay your pods out on drying racks, a clean metal surface, or even on a clean cloth spread over the ground during the day. Do this in an area that is free from animals that could contaminate the pods. At night, you must bring your pods inside to prevent evening and early-morning moisture from being absorbed; this also applies whenever the weather starts to turn cloudy and humid. The sun-drying process can only be done on days with high temperatures, low humidity, and low cloud cover.

Bruchid beetles will likely hatch out of the pods during drying and storage (they are what make the small holes in the pods), but this is not something to cause alarm since they are harmless. To avoid hatching beetles and to dry pods quickly the recommended technique is to kill the eggs by pasteurizing the pods at low temperatures in a regular oven or, preferably, a solar dryer or solar oven. If you plan to pasteurize the pods, it's recommended that you sun dry them for one full day beforehand. If you are not going to use any additional drying methods, you can solar dry them for two to three days, depending on temperature and humidity.

According to the current science on treatment for mesquite flour processing, temperatures above 144°F (62°C) kill all insects in less than 1 minute, temperatures from 122°F (50°C) to 144°F (62°C) kill all insects in less than 1 hour, and temperatures of 113°F–122°F (45–50°C) killed all insects in less than 1 day.

Keep in mind that this refers to the temperature to which insects are being exposed, not the temperature that the oven is set to. Longer times are required to make sure that the innermost parts of all mesquite pods, and thus the insects, are actually reaching

these temperatures. Let the pods cool down before storing them. This treatment should bring down humidity to around 6% from the 12% that can be attained by solar drying alone.

Guidelines for Drying Mesquite Pods:

- Mesquite pods should be fully dried as soon as possible after harvesting and before storing and milling.
- Solar drying should only be done on days with high temperatures and low humidity; always store the pods inside at night and whenever the weather changes.
- If possible, pasteurize the pods by heating them to 126–140°F (52–60°C) for 35–40 minutes, let them cool down, and store them in airtight containers.
- If you are not able to completely dry your pods before storage, freezing them can be a good alternative. Make sure to dry them thoroughly after they defrost since they will absorb additional humidity.

Hammermills are ideal for grinding mesquite pods quickly and efficiently, making it possible to scale production.

Storing Mesquite Pods and Their Products

Once the pods are completely dry, it's important to store them appropriately to prevent them from absorbing humidity and to protect them from insects and other vermin that could damage or contaminate them.

Guidelines for Storing Dry Mesquite Pods:

Store the dry/brittle pods in food-grade polyethylene grain bags, buckets, plastic barrels, or other plastic containers that are dry, clean, and have not been used to store chemicals of any sort. Close tightly. Note: Polyethylene grain bags are not a good barrier for moisture and should only be used if the humidity of the storage space is constantly low or if you are going to freeze the pods for storage.

- Store in a dry, temperature-stable and vermin-free location until milling.
- Pasteurized pods can be stored in containers with airtight lids and will remain totally bug-free.
- Double-bag them in horizontal chest freezers.
- Containers for sun-dried (non-pasteurized) pods will need to be opened every few days to release the hatched bruchid beetles and prevent these newborn beetles from laying new eggs on the pods. The beetles usually collect at the bottom, so this can be tricky.

Milling Mesquite Pods for Human Consumption

The milling process is key to transforming the whole pods into fine mesquite flour. Again, it's extremely important to bring the humidity of the pods as low as possible during the drying process. Do not grind pods that don't feel completely dry; they should snap easily when bent and should feel firm to the touch. The more moisture present in the pods, the more difficult the cleaning of the mill.

The ideal type of equipment to grind mesquite pods efficiently and quickly is a hammermill—this type of mill has a series of metal plates attached to a high-speed rotating shaft that pulverizes pods by impact, not by friction. Hammermills can be run by electric, diesel or gasoline engines, and can be made of regular or stainless steel; the latter is ideal, and, indeed, might be required, for commercial mesquite-flour operations.

Milling mesquite flour at Mission Garden, Tucson, Arizona. The Garden periodically conducts workshops to demonstrate various techniques for working with native food sources.

At least 30 hammermills have been purchased by individuals, nonprofits, and communities in the borderland states to provide local markets and families with mesquite flour from their own habitats.

Hammermills easily break up the pods and some of the hard seeds to produce quality flour containing both carbohydrates and protein, and are, therefore, the best choice for milling mesquite flour. The powder will be forced to pass through a screen inside the hammermill to achieve the required particle size to attain a fine flour texture.

The model widely used in Arizona and Texas is the Meadow Mill No. Five Model GX390U1QNE2. This model has become the mill of choice for milling managed by community co-ops or nonprofits. (An operating manual for these larger-scale mesquite pod mills ($4,000–$6,000 per mill) can be found on the Desert Harvester's website.) South American algarobba millers of mesquite flour use more inexpensive ($700–800) tabletop hammermills which can still process several kilos or pounds per hour.

The ductwork on this Meadow Mill hammermill directs the screened mesquite flour from the mill's fan to the funnel bag, and then to a large container in which the flour collects. The funnel

bag can be clamped to the ductwork with a bungee cord so it can be quickly removed or replaced as needed. Flour dust (pastry flour) is collected in the filter bag, and if collected in sufficient volume can be a second saleable product.

Use a 1/64–inch (.41 mm) heavy-duty screen (usually available from the hammermill manufacturer. If this is not available in your region, you can glue a 1/64–inch stainless-steel mesh to a 1–inch (25.4 mm) heavy-duty screen, but in this case it's best to grind the pods first using a 2–mm (0.08–inch) heavy-duty screen so that the pods don't damage the thin stainless-steel mesh.

If hammermills of any kind are out of your price range, other flour mills will work if the pods are broken into pieces and toasted so that they are extremely brittle and easy to pulverize. Be aware that they gum up the mills enough to require frequent cleaning. Heavy-duty blenders have been used but are vulnerable to gumming up and tine damage. Some household blenders are simply not durable enough to mill pods. Of course, you can go the low- tech way with a mano grindstone and a metate pestle….

Keep in mind that any milling method that works by friction will generate heat and that heat will caramelize the sugars in the pods, making the flour stick everywhere inside the mill and reducing the quality of the final product. Whichever kind of mill you use, sifting out seeds and partially broken chunks of pods from the flour is necessary. This process seldom takes more than two siftings. The resulting sifted flour must be stored under dry conditions where humidity does not change much over the season, or the moist flour itself will gum up into hard cake-like chunks. Triple-ply bags or double layers of air-tight, food-grade Tupperware or hard plastic containers with desiccant between the two walls work best.

For more terrific information about the volumes, weights and processes for milling pods, see the Desert Harvesters' 2016 book Eat Mesquite and More or visit their website, beginning with this page: https://www.desertharvesters.org/how-we-run-mesquite-millings/time-volume-value-of-pod-harvests/

Once the pods have run through, turn off the mill, empty the flour from the filter bag into a bucket, and remove the chaff from atop the screen in the milling compartment. Chaff removal is the slowest part of the process because you must make sure the chaff does not slip by the screen into the lower compartment from which screened flour will be blown into the filter bag.

Chaff must also be removed from around the mill's blades. All this can be done by hand, but the fastest method is to use a wet/ dry "shop vacuum" dedicated solely to chaff removal. The chaff collected by the shop vacuum can then be reused to make mesquite drinks, mesquite beer, or fed to livestock. If chaff is

Mesquite's use as a food has expanded to include products such as flour, seasonings, mesquite cappuccino, mesquite lemonade, beer, wine, and mead.

not regularly removed, the mill will overwork the motor and the pods will not be properly ground; the motor could also overheat and be damaged.

Guidelines for Milling Mesquite Pods:

- Unless your pods were pasteurized and stored in an airtight container, you should separate them from any bugs collected at the bottom and place them in the sun for their final drying before milling.
- It is important that pods are absolutely brittle dry when they are brought in for milling. Soft or unripe pods clog and slow the hammermill's operation.
- To ensure the correct functioning of the hammermill, ensure that pods are totally free of dirt, debris, and small stones.
- Because of the hygroscopic nature of mesquite pods, milling should be done during the dry months to avoid the reabsorption of atmospheric moisture.
- Make sure the inside of the mill is clean as well as the funnel bag and the filter bag.
- Refer to the operation manual of your hammermill and follow all safety guidelines. It's especially important to use eye and ear protection gear as well as puncture-resistant gloves that can be kept clean easily.
- Depending on the desired texture, the flour that comes out of the mill may need to be sifted manually one more time before packaging.
- Store the final product in airtight bags or containers that don't let humidity through.
- Keep bags in a cool area.

Care must be taken when harvesting mesquite to ensure food safety:

- Harvest is before the summer rains
- Harvest directly from the tree rather than the ground

Mesquite Syrups and Molasses

For thousands of years, the local terms for "sugar" in the Middle East primarily referred to carob pod molasses rather than sugar from beets or sugar cane. As noted earlier, carob trees are the Old-World equivalent of mesquite in their nutritional importance in desert regions, so that any processing technique or recipe that works for carob works for mesquite. For those who wish to use the pods for syrups, molasses, or beverages rather than milling them for flour, it is easy to infuse dried, broken pod fragments in water, preferably by placing them in a cheesecloth bag and pressing their moist must or mash through the cloth, then discarding the larger contents remaining in the bag.

Below is a recipe greatly adapted from Barbara Massaad's recipe for carob molasses—Dibs el-Kharroob—which works for mesquite pods. The recipe, and a beautiful account of Lebanese molasses-producer Bassam Naimeh, are in Masssaad's classic book, Mouneh: Preserving Foods for the Lebanese Pantry

Recipe Dibs el-Kharroob

11 lb (5 kg) of cracked mesquite pods, roughly ground and deseeded

9 gallons (34 liters) cold water 2–3 drops olive oil

- Soak the cracked, ground mesquite pods in cold water for 3 hours in a carboy or large plastic basin.
- Drain and filter the mesquite must through a fine sieve or colander, keeping the liquids and tossing the solids. For large quantities, repeat the process 2 or 3 times.
- Add drops of olive oil to reduce foaming of froth.
- Bring slowly to boil, stirring and skimming off froth frequently for two to three hours, reducing the vol- ume until the liquid is the thick consistency of syrup or molasses.
- Pour the hot liquid through strainers into sterilized jars, filling them to the brim; wipe their rims with a cloth then seal.
- Label the jars with date and store in a cool, dark place for up to one year.

Use syrup to top casseroles or ice cream, as the base of a carbonated beverage with 1 tablespoon of syrup for 8 ounces of water and ice; as an ingredient in cookies, cakes, or salad dressings; or to ferment into mesquite wines or ciders.

CHAPTER FIVE

Making Mesquite Liquid Smoke, Seasoning Powder, and Other Flavorants

PROSPECTS FOR INCOME GENERATION

Of the many economic products derived from mesquite trees, liquid smoke, wood chips, fire-roasted dried pods and other seasonings for barbecues, cheeses, and other food products are perhaps the easiest to forget, dismiss, or ignore. And yet, per unit weight, they are among the most lucrative value-added non-timber forest products derived from mesquite trees. The US market alone for liquid smoke is already at US$ 70 million (MX$ 1,395,146,687) a year, and by 2032 is anticipated to reachUS$ 150 million (MX$ 2,989,600,045) in revenues. The overall global market—including Mexico as a leading consumer—is anticipated to reach US$ 110 million (MX$ 2,192,373,366) by 2027.

Although hickory smoke remains the current leader in the US market, the familiarity of and preference for mesquite's aroma and flavor may soon edge out hickory in the global market. Remarkably, mesquite's segment is estimated to register the fastest rate of growth of any other liquid smoke, with a projected 9.1% growth for the period 2021–2026. That may be because mesquite's aroma is strongest among all liquid smokes. Its commercial uses are not at all restricted to barbecue sauces, marinades, and rubs. Mesquite liquid smoke and seasoning powder are also used in trail mixes, crackers and jerkies, baked beans, salad dressings, gravy, and dog foods.

Liquid mesquite, hickory, and pecan smokes are produced on a commercial basis in the US, Mexico, Brazil, Southeast Asia, Japan, and China. There are no good statistics on the number of workers employed in producing mesquite smoke for the barbecue and seasoning industries. The barbecue and grill market in the US was barely US$ 50 million (MX$ 1,008,250,514) a year in the 1950s, but reached US$ 343,600,000 (MX$ 6,930,438,292) in 2020. The US and Canadian charcoal market for grilling and barbecuing is projected to grow to US$ 466,000,000 (MX$ 9,399,857,366) US by 2030, with hidden costs to all of us because of its contribution to greenhouse gas emissions and air contamination.

HOW MESQUITE GETS TRANSFORMED INTO LIQUID SMOKE

Liquid smoke, also called wood vinegar or *pyroligneous* acid, is typically an orange red or yellow colored liquid used as a

38 million grills burning for 1 hr

Equal

42,000 car emissions for 1 day

water-soluble seasoning or vinegar-based flavorant for quick basting, marinating, or rubbing onto foods grilled over a fire. Liquid smoke is esteemed for its capacity to enhance the wood smoke aroma in grilled meats, seafoods, cheeses, or other foods. It is essentially a natural byproduct of burning wood that is sometimes enhanced by adding mushrooms, sun-dried tomatoes, or eggplant, which also offer the mouth-watering *umami* (savory or meaty) sensation.

The smoke from any burning wood and its accompanying steam, and water vapor can be captured and condensed through coiled tubing to capture their smokiness. Mesquite liquid smoke can then be processed and purified into a thick liquid to eliminate its ash and soot, or combined in powders with ground herbs, mushrooms, and dried tomatoes to produce rubs and bastes for meats, seafoods, dairy products, pet foods and vegetables. Mesquite wood chips, fire-roasted pods, or pod flours may offer similar aromas and flavors.

Liquid smokes serve as all-natural, antimicrobial food preserving agents, flavorings, and seasonings that are employed worldwide, but especially in hotter climates. These smoke-imbued liquids are all-natural ingredients for foods and beverages that have been traditionally produced by smoldering—a process that has a low efficiency, causes air pollution, and contributes to global carbon emissions. Thankfully, these old processes are now being replaced by *biomass pyrolysis*, an advanced thermochemical process that can replace smoldering. (Basically, pyrolysis is the heating of an organic material, such as biomass in the absence of oxygen.) In essence, a transition has begun in liquid smoke production toward a circular process with less waste and pollution.

New opportunities exist to "green" the barbecue and grill industries. By producing liquid smoke using wood shavings and pods that would otherwise be discarded, we could obtain mesquite's smoky flavor, with fewer emissions than charcoal.

If the charcoal market were to grow as expected, smoked meats and glowing embers would come into the market with significant ecological and human costs at every stage. To put all of this into perspective, here's a look at the hidden costs of charcoal from creation to cookout: if each of the 38 million owners of charcoal grills in the US decided to fire up their barbecue for just one hour on the next holiday, they would collectively release more than 427 million pounds of carbon dioxide into the air on that day alone. Unfortunately, that's roughly the equivalent to the year-long greenhouse gas emissions from 42,000 gasoline-powered cars. In short, there is an immediate economic opportunity and ecological need to produce low-carbon options to mesquite charcoal for the barbecue industry. Unless interventions like this occur, ***the North American charcoal mar-***

ket alone is set to grow to US $466 million (MX$ 9,287,051,112) by 2030, emitting more greenhouse gases than ever.

For now, you can make liquid smoke at home or in community kitchens using the following guidelines, but substituting mesquite wood shavings, chips, whole mesquite pods, or pod milling byproducts.

MAKING LIQUID SMOKE AT HOME OR IN COMMUNITY KITCHENS

Traditionally, charcoal grills, meat smokers, and chimeneas have been used to produce liquid smoke, however, due to environmental consequences of burning wood and charcoal, dedicated gas smokers are now the preferred option.

Items Needed to Make Liquid Mesquite Smoke: Smoker; Newspaper; Chimney starter; Charcoal; Tongs; Lighter; Mesquite wood chips; Dried, mature mesquite pods; Large bowl; Water; Colander; Aluminum foil; Bundt pan; Metal mixing bowl; Ice packs; Funnel; Small glass jar

Step 1. Set up Your Fire Source

Let the smoker heat up to high heat, or about 300°F (149°C). Smokers typically cook foods at a lower temperature and use less fuel than grills, because they are designed to cook through smoking rather than direct heat.

Step 2: Smoke the Mesquite Wood Chips and Mesquite Pods

Choose your wood chips. You can use just about any wood you like for smoking and making liquid smoke. Mesquite wood, among all North American woods, ranks as having the smokiest taste, while the mesquite pods can be added to impart a slightly sweet and fruity aroma.

Soak the wood chips for 30 minutes. Wood chips are small and can ignite easily, so it's important to soak them before smoking. Transfer about 2 cups (180 g) of chips to a large bowl and cover the chips with water. Let the chips soak for half an hour. Larger wood chunks don't have to be soaked prior to smoking.

Drain the wood chips and add dried mesquite pods to them. Transfer the chips to a colander. Leave them in the colander for about five minutes to allow excess water to drain out. This will help the wood heat up faster. Add a handful of dried mesquite pods.

Wrap the mesquite wood chips and mesquite pods in foil. Transfer the drained chips or chunks into the center of a large piece of aluminum foil and fold up the sides of the foil to make an open pouch to hold the chips and pods. You can use a wood chip

The smoky aroma of mesquite that barbecue masters love need not come from cutting down trees – the pods, as well as shavings from furniture making, impart mesquite flavor to allow a new green means of making mesquite barbecue sauces, bastes, and rubs.

smoker box instead of the foil if you have one. Place the chips and pods in the box and put on the lid.

Place the mesquite wood chips and mesquite pods in the smoker. Use a pair of barbecue tongs to pick up the package of wood chips and pods.

Cook food on the smoker as you smoke the chips and pods. You can cook meat, vegetables, or other food on the smoker while you're capturing the liquid smoke. Not only will this make the most of the hot smoker, but it will also impart a unique flavor to your liquid smoke.

Step 3. Capture the Smoke

Place a Bundt pan on top of the chimney. Close the lid on the smoker. Slide the Bundt pan over the top of the chimney, so the chimney is venting through the hole in the middle of the pan. A Bundt pan is ideal for this job because the hole in the center of the pan will allow heat and moisture to rise through the middle.

Cover the Bundt pan with a mixing bowl. Find a heat-proof metal bowl that's the same diameter as the Bundt pan. Turn the bowl over and use it as a lid to cover the pan below. Now the heat, smoke, and moisture that rise through the center of the Bundt pan will be trapped by the bowl and collect in the pan below.

Cover the bowl with ice. Place a few hard-frozen packs of ice on top of the upside-down metal bowl. The difference in temperature between the hot smoke and the cold bowl will cause a smoky condensation to form on the top of the bowl. This will then drip down into the Bundt pan as liquid smoke that you can collect. Instead of ice packs, you can also use a bag of ice, or a freezer bag filled with ice.

Allow the mesquite wood chips and pods to smoke for an hour. You'll know they're done when the food is cooked, or when the coals burn out. An hour will give the bowl and Bundt pan setup enough time to collect at least a few tsp (several ml) of liquid.

Collect the liquid from the Bundt pan. When the coals have burned out and the wood chips have released all their smoke, carefully remove the bowl and Bundt pan from the chimney. Protect your hands with gloves, as the metal may still be very hot.

Bottle the liquid smoke. Remove the bowl from the top of the Bundt pan. Place a funnel into a small, sterilized glass jar and pour the contents of the Bundt pan into the jar. Remove the funnel and seal the jar with an airtight lid. Store the liquid smoke at room temperature until you're ready to use it. For the best results, use the liquid smoke within 6 months.

A NOTE ON GRILLING AND THE ENVIRONMENT

While the environmental impact of mesquite grilling or smoking may appear to be negligible compared with most of the other emitters of carbon, we can learn to *"grill green"* by changing how we grill and what products we purchase:

Avoid petroleum-based lighter fluids and self-lighting charcoal since they release petrochemicals into the atmosphere. Instead, use electric charcoal starters, charcoal chimney, or natural lighter fluids to get your fire going.

Be selective on charcoal purchases. Avoid "mesquite" from desert areas where threatened ironwood trees have been cut and tossed in with the mesquite. Buy natural charcoals and lump charcoal made from furniture scraps and waste wood.

Switch to gas or natural gas smokers, which are much more energy efficient than charcoal grills and produce far fewer pollutants.

Reduce preheat times, by realizing smokers are ready to cook in 5 to 10 minutes.

MAKING SMOKED MESQUITE SEASONING POWDER RUBS

Surprisingly, many commercial and homemade "mesquite" powder mixes for meat rubs, bastes, and other seasoning strategies do not include mesquite ingredients at all, but mimic them by capturing their *umami* using ingredients other than mesquite wood chips or pods! The following open access recipe, suggests using fire-roasted ground mesquite pods as the key ingredient, plus others associated with smoky mesquite products as supplemental seasonings.

Mesquite Seasoning Powder Recipe

Ingredients

1 ½ Tbsp smoked paprika

5 Tbsp fire-roasted mesquite pod flour or 2 tsp homemade liquid smoke from mesquite shavings, pods, or chips

2 tsp dried porcini mushroom powder

1 tsp cumin

1 tsp brown sugar or Mexican panocha in piloncillo cones

½ tsp garlic powder

½ tsp onion flakes

2 tsp fresh rosemary needles ground in coffee grinder

½ tsp marjoram

¼ tsp sage

¼ tsp freshly ground allspice

¼ tsp ground mustard seed

¼ tsp smoked chipotle powder

¼ tsp mustard powder

1 tsp freshly-ground black pepper

2 tsp Kosher salt or smoked salts

Instructions (Prep Time 5–10 minutes)

Mix all ingredients in a large bowl, then sift out large particles through a colander-like sieve. Pour into an air-tight glass jar or other container. Spice mixture will keep 2–3 months in an air-tight container in the pantry. For gifts or sales, place in 4- to 6-ounce 3-ply bags and seal.

Rubs made from mesquite seasoning powder impart great flavor to foods from meats to vegetables. There is great potential to expand this market.


THE TRADITIONALS
MADE WITH RAW
The Meading Room
PURE
HONEY
VERDE RIVER
MESQUITE
2018 NET WT. 10 oz.

CHAPTER SIX

Mesquite for Honey and Other Honeybee-Derived Products

PROSPECTS FOR INCOME GENERATION

Mesquite honey is one of many varietals produced by honeybees and widely used as a source of sugar. It is consumed in tea, or used to sweeten pastries and prepared foods, and to ferment mead (a yeast-based beverage), true honey wine, and honey beer. It also has a high value for the cosmetic and pharmaceutical industries, as more and more beauty products such as creams, soaps, shampoos, and medicinal preparations include it as an ingredient. A smaller volume of honeybee- derived products is wholesaled and packaged for the domestic market, as well as some byproducts such as wax, propolis, pollen, venom, and royal jelly.

By 2020, there were about 94 million beehives in the world. The US is the fifth-largest honey producer. US honeybee colonies decreased to 2.71 million in 2020, in part due to drought, freezes, agrochemicals, and pandemic disruptions of the workforce and economy at large. Between 2020 and 2021, a third of all colonies were lost in the US.

In 2021, the production volume of all honey in the US amounted to approximately 126,500 pounds (57,379 kg). Texas is the only mesquite-honey-producing state in the top ten, with 8,482,000 pounds (3,847,370 kg) of all types of honey produced in 2021. That is eight times more than in the mesquite-honey dominated state of Arizona, which produced 1,040,000 pounds (471,736 kg) in 2021. Arizona honey production is up 16% from 2020, and now involves human management of more than 25,000 colonies.

In Mexico, honey production has been on the rise in the past decade, with 42,000 beekeepers nationwide, operating 1.9 million hives—about 70% of the number of colonies managed in the US. Over the past five years, Mexican hives have yielded about 57,000 tons (51,709 metric tons) of honey a year, making Mexico the world's sixth-largest honey-producing country. Mexico has become one of the largest exporters of organic honey in the world, exporting more and more mesquite honey to the US when drought diminishes production north of the border.

Bulk drums of honey, weighing 661 pounds (300 kilograms), are largely for export. They are produced by only the largest producers with mobile colonies. The average US consumer used one pound (0.45 kg) of honey per year in 2021 versus a half pound (0.2 kg) in 1990. Increased demand created higher retail prices for

honey, which have risen consistently since 2018. The retail price per pound of honey was around US$ 8.00 (MX$ 160.38) by 2019. Mesquite honey currently imported from Mexico into the US costs approximately US$ 7.93 MX$ 158.6) per kg or US$ 17.48 (MX$ 349.6) per pound.

Value-added products for domestic consumption are on the rise. Prickly pear cactus fruit and red chile honey products have small niche markets but return good profits relative to the investment. The global mead beverage market is projected to grow from US$ 487.9 million (MX$ 9,738,947,177) in 2021 to USD$ 1,621.0 million in 2028 at a Compound Annual Growth Rate (CAGR) of 18.71%. In the US, mead is the fastest growing segment of the US alcohol industry. The US only had 30 commercial meaderies in 2003, rising to 300 in 2016 and growing to more than 400 by 2022.

As southern Arizona beekeeper Monica King has noted, European and Africanized Honeybees of the Sonoran Desert and adjacent uplands must rely on mesquite as the major floral source not only for their carbohydrates (nectar) but also for their protein (pollen). So must their caretakers. As beekeepers looking over the valleys of mesquite grasslands and savannas between the Sky Islands of the borderlands, it can be stressful to know that it is literally feast or famine for the honeybee if mesquite habitat is not managed well. Beekeepers must manage the demographics of their hives to coincide with the mesquite bloom, which can vary between increasingly common drought years and the rarer wet years. Attention to timing ensures the colonies will have excess honey for the beekeeper to harvest.

PROPERTIES OF MESQUITE HONEY AND PROPOLIS

According to beekeeper Monica King, mesquite honey is considered a gourmet or specialty floral varietal and demands a higher price due to the lower supply usually available. While food use of mesquite pods is considered a direct food from mesquite trees, the indirect food use created by the mesquite trees—honey—is currently relished by many more Americans and Mexicans. Mesquite trees have been a popular source of nectar for honey production for well over a century. Bee foraging was measured to understand flowering and pod production of the *Prosopis glandulosa* var. *glandulosa* in relation to honeybee pollination. The increased number of pods from the tree had an association with increased number of visits by bees regardless of nectar production.

Since early historic times—1750 AD—mesquite honey was considered by Indigenous peoples as a natural treatment for certain conditions or diseases. More recently, studies confirm that mesquite honey may have some capacity for stabilizing sugar levels in diabetics. Mesquite honey often contains considerable quantities

What is Propolis?

If you've ever seen a beehive at a farm or at a farmer's market, you may have been curious about how the unique structure holds together. The stability of a natural beehive is largely attributed to the sticky plant-based resin known as propolis, also called "bee glue," which is located inside the hive. Bee propolis is also considered a superfood of sorts, providing essential nutrients to support optimal health in bees – and humans!

nhc.com/propolis

of *quercetin*, a phytochemical with antidiabetic properties. It may also have antiseptic qualities, and it has been used as a natural remedy to treat sore eyes after dust storms. It has also been recommended for treating skin wounds, rashes, and burns.

Humans have been using *propolis* medicinally since ancient times. Numerous clinical studies and other research in natural medicine has suggested *propolis* has antiseptic, anti-inflammatory, antioxidant, antibacterial, antimycotic, antifungal, antiulcer, anticancer, and immunomodulatory properties.

THE MANAGEMENT OF HONEYBEES THOUGH THE SEASONS

European queen bees slow down egg laying during winter months, thus dropping the population for the colony to make it through the dearth. A rule of hive maintenance is for every one frame of brood that is present in the hive, you need one frame of honey and one frame of bee bread (pollen) and the equivalent amount of water to raise/feed that one frame of brood. Beekeepers have a lot of money invested, and future income is at risk, so if those are not seen on inspection, the hive must be fed to supplement against starvation. Some may say that allowing the hive to fend for itself will create "survivor" stock, however, too many factors are involved to support that conclusion.

An early protein source that triggers the bees into brood production is hosted by the mighty mesquite-desert-mistletoe, a parasite in its branches. Though the flowers are almost unnoticeable to humans, the hum surrounding a blooming cluster of mistletoe is music to a beekeeper. This natural pollen gathered stimulates both maintained and feral hives into a fury, knowing spring is around the corner.

The hives must reach peak forage population during the mesquite tree's nectar flow. From the day the queen lays a worker bee egg, it takes approximately 21 days before she emerges from her cell. That worker bee, though she has many important casts during her days ahead, will not reach forage age until she is 22 days of age. She will forage nectar, pollen, and water until the end of her life: a ripe old age of 45 days. A strong hive, full of a forage-aged workforce, can produce 30–60 pounds (13.6–27.2 kg) of honey and after a wet winter year upwards of 100 pounds (45.3592 kg).

These numbers are also useful when discussing requeening of feral Africanized hives. Africanized honeybees are unpredictably defensive and have a much quicker response time, depositing a higher number of potentially life-threatening stings. Africanized honeybees also swarm more frequently than European honeybees—three to five times a year. This can decrease their forage work force during the time of peak honey production. By replacing the Africanized queen with a known European queen, the

In the Sonoran Desert and adjacent uplands, bees rely on mesquite as their major floral source for carbohydrates (nectar) and protein (pollen).

hive's genetics will change over in 21 (last egg-laid days to emerge) plus 45 (worker bee lifespan) +/- a few days, depending on season.

Past research in Mexico concluded that an average of around 23 feral hives per square mile is supportable in mesquite habitat, and in southern Arizona, a good density is somewhere between 10–13 per square mile. The Africanized honeybee also is known to establish their homes in areas that European swarms would likely not choose. Mesquite trees can double as home and food source at the times as "open air hives". These hives can have comb exposed

Beekeepers often use smokers to calm bees before collecting honey in the wild.

to the elements yet protected enough by the mesquite's canopy and/or mistletoe clusters. This is actually more common than the use of a hollow trunk.

The brood chamber must remain around 93°F (33.89°C) year-round, no matter the ambient temperature. Again, going back to demographics, the young worker bee population keeps the temperature regulated by creating heat with their bodies or cooling by fanning open cells with deposits of water brought in by the forage bees, in short, a form of evaporative cooling.

Bees will gather mesquite exudate and mix it with their saliva and wax to produce a unique product from the hive called propolis. Bees use this substance as a "glue" to fill small gaps (1/4 inch or less), reducing drafts and protecting the hive from rain. It is also used to reinforce the hive's structural integrity, provide thermal insulation, and mummify unwanted guests (lizards, mice, pack rats, etc.). The bees will use propolis to narrow entrances in defense against predators. Even more importantly propolis has antifungal and antibacterial properties protecting the colony from pathogens. By collecting the exudate from the mesquite, as well as other desert native and non-native plants, the bees are literally harvesting the essential oils that are distinctly associated with the heterogeneous vegetation of the Sonoran Desert region. Thus, the composition of propolis varies from hive to hive, location to location, and season to season. On average, propolis has been found to contain approximately 50 constituents, primarily balsams and resins (50%), wax (30%), essential oil (10%) and pollen (5%).

New Trends

The US National Honey Board is promoting greater attention to sustainability among producers and consumers in the following ways:

- **Supporting bee health** through more diligent hive management, avoiding pesticide impacts, and protecting the beekeeping profession.
- **Championing pure and varietal honey** by protecting purity and traceability.
- **Nurturing the planet** by limiting impacts from waste/packaging, greenhouse emissions, and pumping water.

New market opportunities exist in the differentiation of honey varieties, especially from *kiave/* mesquite honey from Hawaii, which has received international acclaim. In recent years, global market trends have shown that consumers prefer a product clearly identified by its floral origin, which can become another market opportunity if place-based production, certification, and labeling come into play for mesquite honey.

The Meading Room in Sonoita, Arizona, serves a variety of beverages made from mesquite – mead, wine, and ciders are favorites.

CHAPTER SEVEN

Managing Mesquite Grasslands for Livestock and/or Wildlife

PROSPECTS FOR INCOME GENERATION

One of the most important economic contributions that mesquite trees make to the US and Mexican economies is as a source of forage, shaded shelter, and breeding grounds for livestock and for wildlife. Managing the tree densities, trunk numbers, brush concentrations and canopy shape of mesquite trees on rangelands for livestock, wild ungulates, and game birds can be costly but returns economic benefits for many years.

Aside from the direct work with livestock or wildlife, rangeland management has provided a major source of income for outdoor laborers in the ranchlands of the Arid West of the US and Northern Mexico for many decades. Professions involved in mesquite management include range management consultants, ranch managers, cowhands, wood cutters and pruners, brush-hog operators, tractor and bulldozer operators, herbicide sprayers, wildlife technicians, and ecological restorationists. Of the third of the US classified as wild rangeland vegetation for free-range cattle, sheep, goats, and bison, roughly 350,00 square miles (906,496 km) includes mesquite species among the dominant tree cover. As much as one-half million square miles (804,672 km) of Mexican rangelands are also covered by fast-growing, nitrogen-fixing mesquites that require periodic management by ranchers and other landowners or lessees.

Visitors can travel through the semi-arid or arid reaches of North America and seldom see many livestock on the range, so they often dismiss rangelands as food-producing landscapes. They fail to realize how significant meat production from wild vegetation like mesquite grasslands and savannas is to American economies.

About 4% of US meat retail and food service sales is comprised of so-called "grass-fed" livestock—which undoubtedly includes "mesquite-fed"—with an annual value often exceeding US$ 4 billion (MX$ 81 mil millones). About US$ 3 billion (MX$ 60.8 mil millones) of that is "unlabeled" grass- (or mesquite-) fed meats from arid or semi-arid rangelands, which is routinely lumped in with conventional beef, lamb, goat, or bison, making data gathering on these products difficult to obtain. Conversely, somewhat less than 1% (US$ 1 billion, MX$ 19 mil millones) of the total US meat market share is grass-fed meat products from rangelands that are explicitly labeled, handled, and marketed as such, for which more-consistent data is available.

While no one that we know explicitly markets their meat products as mesquite-fed or mesquite-finished, the pods and foliage of mesquite provide beef, lamb and goats raised on desert and semi-desert rangelands with the mesquite's characteristic flavor profiles. Chromatographic analyses accomplished in meat labs have documented that many of the peaks in flavor components that distinguish "grass-fed" from "corn-finished" beef come from a diet rich in legumes, rather than just from grasses. In addition, many cattle in the border states of Mexico and the US rely on mesquite pods and forage for 6–9 weeks prior to the arrival of summer rains that stimulate the greening up of perennial grasses and annual forbs in the summer.

Wildlife conservation efforts include reducing upland mesquite invasion and conserving valley migration corridors for wildlife such as the pronghorn antelope.

In severe drought years when few grasses ever green up, it is often the foliage, flowers and pods of mesquite and other tree legumes that help cattle survive the driest months with the least production of seasonal forage. Those happen to be the years in which prudent management of mesquite resources—including putting up pods for silage—can make or break the economic success of a desert ranching operation.

Government subsidies for range improvement and fire-risk brush control through programs such as the Environmental Quality of

Incentives Program (EQIP) through the US Natural Resources Conservation Service (NRCS) and (Natural Resource Conservation Districts (NRCD), or Payments of Ecosystem Services (PSAs) through the Mexican Comisión Nacional Forestal (CONAFOR) can help pay adequate salaries for the skilled labor to better manage mesquite for both livestock and wildlife productivity, and for carbon sequestration.

Principles for Managing Mesquite Grasslands, Savannas, and Bosques

To better manage mesquite for livestock and wildlife production, we must first recognize that there are many distinctive kinds of mesquite-dominated vegetation, so there is no one-size-fits-all management strategy. In truly desertic vegetation, mesquite may be a sporadic member of woody vegetation dominated by a dozen or more woody trees and shrubs, as well as by succulents like agave, prickly pear, and columnar cacti. Grasses comprise a small proportion of the forage in such hyper-arid, subtropical desert scrublands. Desert grasslands and plains grasslands may have sporadic mesquite trees that comprise only 5–10% of the total vegetative cover. Mesquite savannas may have trees or shrubs that make up 10–20% of the vegetative cover when properly managed, or 20–40% of the cover where overgrazing and poor management have persisted. But in riparian zones, healthy stands of sizeable mesquite trees may form closed canopies where few other plant species are co-dominant and may reach 80–100% ground cover. These closed-canopy mesquite bosques in riparian corridors are rare today, and may be too shady for livestock use, but they offer key habitat to many wildlife species.

The four key concerns of ranchers regarding mesquite are:

- Reducing total mesquite canopy cover per acre to less than 20%, which is the presumed threshold for woody brush cover competing with grasses and forbs for water and nutrients.
- Reducing resprouting of mesquites from the base of stems or trunks so that animals can reach into the shade for resting, nesting, or birthing.
- Maximizing trails or passable corridors through mesquite brush for herds, flocks, and off-road utility vehicles for fixing fences and waterers.
- Reducing fire risk to adjacent properties, equipment, or structures.

To reduce mesquite canopy cover below the 20% threshold, mesquite artisans need to assess standing density and size before brush control begins, and consider other uses of the same pasture other than livestock production—beekeeping, pod production, quail hunting, etc. If the mature mesquite trees dominate and reach 30–foot (9 m) diameters, you can keep just 24 trees per acre

Warblers and other birds nest and feed around mesquite trees.

and thin or burn out smaller ones. If their canopies average 15 feet (4.6 m) in diameter, you might want to thin to just 50 single- or few-trunked trees per acre. If most mesquites on the land are multi-stemmed shrubs averaging 5–foot (1.5 m) diameters, you can keep as many as 450 plants per acre (0.4 ha) or prune larger ones to extend their canopies over time and then lower that number to 360 trees per acre, and later to 200.

There are ranchers who choose to eliminate all mesquites and other woody brush from pastures, but the costs of doing so can be great or even prohibitive to the majority of ranchers. Various strategies include chaining or grubbing, controlled burns, direct application of herbicides to sawed-off stumps of live trees, chainsawing or pruning tree stems just below ground level so as not to encourage suckers or lateral resprouting. If chainsaws and pruning shears leave stems above ground, they must be treated with motor oil or herbicides within two minutes of the cut to ensure low probability of resprouting. All offer mixed success.

There are ranchers who choose to eliminate all mesquites from their pastures, but the costs of doing so can be great.

Guidelines for Mesquite Rangeland Management

- Establish long-term goals, and work toward meeting certain objectives each season or year, rather than all-at-once.
- Recognize that total eradication of mesquite is not feasible nor advisable, but stepwise reduction is.
- Focus thinning and pruning efforts on younger, shallow-rooted trees and shrubs.
- Manage more mature trees to reduce stem or trunk number, thicken trunk girth (for later selective woodcutting), and spread canopy like an umbrella over a shaded area you can stand within.
- Plan to re-prune or selectively reduce densities every 3 to 7 years, uprooting new seedlings when not desired.
- Keep corridors and management options open for co-locating beehives, wildlife waterers, blinds and maneuverable trails or fire breaks that provide easy access.
- Encourage deeper rooting and less standing aboveground woody biomass for better carbon sequestration, water and nutrient pumping up into soils closest to ground surface.

CHAPTER EIGHT

Managing Mesquite for Carbon Sequestration

Carbon sequestration is the process of capturing and storing carbon dioxide from the atmosphere to reduce global warming. Biological sequestration in soils occurs as trees and grasses photosynthesize and store soil organic carbon and carbonates. A quarter of all global carbon emissions are captured by natural vegetation in woodlands, savannas, and grasslands. The goal is to increase that amount to slow warming.

PROSPECTS FOR INCOME GENERATION

Of the many "hidden" values associated with mesquite trees, their capacity to pull down and sequester carbon to offset greenhouse gas emissions may be the most critical for slowing or reversing climate change. Carbon sequestration is defined by the amount of carbon pulled down by trees and other plants that remains in the woody tissues of the plants below or above ground or in the soil derived by the plants. Because of that value, landowners and stewards of extensive acreages can now generate and sell carbon "credits" through private markets hosted by "carbon project developers." Through 2020, about 153 million *forest credits* have been issued worldwide, each representing a metric ton of sequestered carbon. These credits are issued largely from swaths of land of 400 ha (100 acres) or more if the woodland management is to generate a profit.

The good news is since the 2008 recession, the average price per ton for carbon credits from forests and woodlands in the West has been gradually, but steadily, on the rise in private, voluntary markets. For forest and woodland restoration initiatives that reduce emissions or remove carbon from the atmosphere, the value rose from $4.33 per credit in 2019 to $4.73 per credit in 2021, with a spike to $5.60 per credit in 2020, each credit representing one ton of carbon dioxide equivalent.

As Stephan Donofrio, the Director of Ecosystem Marketplace, reported in September 2021, "We're seeing record market volume and value in 2021. The markets are on track to hit $1 billion in transactions this year if current levels of activity and growth continue. It's not just companies who are buying carbon credits as a small piece of their corporate net-zero strategy. There's an increase in speculators purchasing credits."

Of course, many ranchers and farmers maintain a healthy skepticism that they themselves will ever gain a penny for managing the trees and other vegetation on their lands from these "speculative" payments for a "service" that up until the last two decades had never been given a monetary value. If less than 1% of farmers and ranchers in the US and Mexico have ever received such payments from governmental or private donors, why should they

have guarded hope that it will happen? One reason is because the value of traded global markets for carbon permits grew by 164% to a record US$ 851 billion in 2021 according to analysts at Refinitiv https://www.reuters.com/business/energy/global-carbon-markets-value-surged-record-851-bln-last-year-refinitiv-2022-01-31/

And yet, it is an undeniable fact that carbon sequestration in US forests offers a significant offset to the nation's emissions of CO2 and other greenhouse gases, and that may have potential economic value in the future. The total area of forests and woodlands in the US has been relatively stable for the last two decades: 290 million hectares (716.6 acres) in 2000 to 289.5 million hectares (715.37 acres) reported in 2019. Because of this relatively stable base of pull-down potential from tree-dominated landscapes, available "carbon stock" has been steadily increasing over many decades. The US Environmental Protection Agency projects that the increases in the amount of carbon sequestered in ***forests, woodlands, urban tree plantings, and their wood products represent the largest carbon sink in the country***, which cumulatively offset more than 11% of the US total greenhouse gas emissions annually.

Without ranches knowing it, their well-managed mesquite savannas have been pulling down carbon and slowing climate change. It's time we reimburse them for doing what was right for the land even before carbon sequestration was cool.

It is not surprising that tree-dominated vegetation usually sequesters more carbon than any other working landscape in the US (though some desert plants like agaves and cacti sequester as much carbon as trees over a 10-year time scale.) Unfortunately, forests and semi-arid or arid woodlands west of the Mississippi have recently suffered wildfires, bark beetle outbreaks, heat waves, droughts, and tree-felling storms that have (temporarily) made them net sources of CO2 in the atmosphere. There is, therefore, a growing need for stewards of forests, woodlands, and savannas in the Arid West to restore or enhance their woody cover without diminishing other values.

Unique Aspects of Mesquite Carbon Sequestration

Mesquite can form both extensive surface roots or profoundly deep tap roots. Maximum mesquite growth has been measured on deep soils with groundwater within 32.8 feet (10 meters) of the surface that can be reached by tap roots. Under favorable conditions mesquite roots can grow up to 1.97 inches (5 centimeters) in 12 hours. Roots of Velvet Mesquite have been found in Santa Cruz County, Arizona, at depths of 160 feet (53 meters).

For many years, the highest carbon sequestration rates per hectare (2.47 acres) yet recorded came from semi-arid Iranian rangelands that were covered with mesquite and other arid-adapted shrubs: 24.03a ± 1.113 metric tons per hectare (2.47 acres) per year. Recently, agronomists working on Via Organica Ranch in semi-arid Queretaro, Mexico, projected that one hectare (2.47 acres) of arid or semi-arid land ***covered by or planted*** with 400 mesquite trees—if the trees achieve trunks of 30 centimeters (12 inches) and 75% shaded canopy cover—can sequester as much as 147 tons of car-

bon on a decadal scale. That's at an average spacing of 5 meters (15 feet) between trees in a row and 5 meters (15 feet) between rows.

Few, if any, advocate for mesquite monoculture but prefer to see mesquites alley-cropped with other perennials or annuals for land health. When mesquites are multi-cropped with agaves (and/or prickly pears) as alley crops between the 400 individual trees, a hectare (2.47 acres) of this desert agroforestry system can pull-down a total of 282 tons of CO2 above ground and at least 20 tons of CO2e below ground (sequestered by the mesquite), for a grand total of 302 tons/ha (122 tons CO2 per acre) over a 10-year period. At $5.00 US per one-ton carbon credit, that amounts to $1,500 US per hectare (2.47 acres) of intercropped mesquite and agaves over a decadal scale, a value that will surely continue to rise. For the 400 ten-year-old mesquites without agaves, the value of carbon pull-down is at least $735 per hectare (2.47 acres) ten years out from planting or pruning.

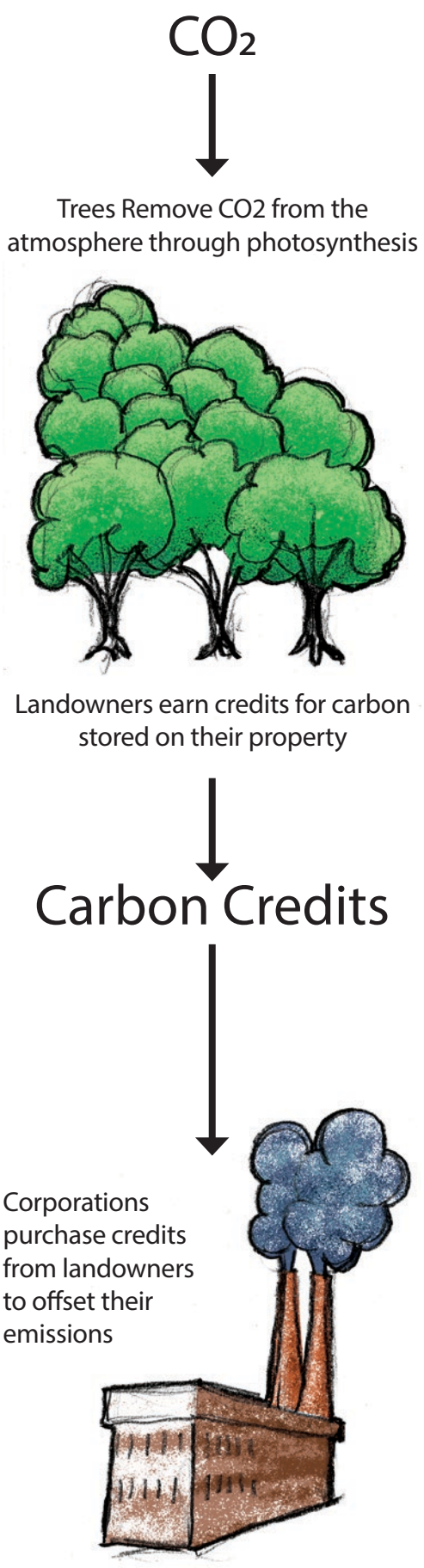
Ronnie Cummins, of Via Organica Farm and the Organic Consumer's Union, calculates that in Mexico—where 60% of all farmlands and rangelands are in arid or semi-arid landscapes, an agave-mesquite agroforestry system has the capacity to sequester 100% of Mexico's current greenhouse gas emissions (590 million tons of CO2e). That is, if it is deployed on approximately 11.6% or 17–million hectares (42–million acres) (2,000 agaves and 500 mesquites) of the nation's total lands (197–million hectares; 486.8 acres). That's no small potatoes!

Currently, Borderlands Restoration Network is establishing three 1-hectare (7.4-acre) plots mesquite carbon-sequestration monitoring plots of pruned mesquite trees on Borderlands Restoration Network lands in Patagonia Arizona, paired with control plots of unpruned trees. They are located in the same three habitats: xero riparian habitats along washes; plains grassland or savanna uplands with fewer than 50–100 mature mesquites per hectare (2.47 acres), and mesquite woodlands with 400–500 trees per hectare (2.47 acres). The plots have marked corner points where all mesquites in three treatment plots are pruned down to 1–3 trunks/plant, while pruned branches are placed downhill from trunks to facilitate water harvesting and retention. Tree height, canopy width and breadth, and trunk diameter at 1 meter (3.3 feet) above ground are measured annually. Soil samples for carbon sequestration analyses will be taken at 0–15 cm (0–5.9 inches), and 15–30 cm (5.9–11.8 inches), and, where possible, 45–60 centimeters (17.7–23.6 inches) below surface.

Promoting healthy growth as we care for mesquites is an important part of our stewardship of this resource.

Considerations for Landowners Interested in Mesquite Carbon Sequestration

Private landowners in arid regions of the US and Mexico might consider collecting carbon credits from mesquite trees on their property for a variety of reasons. Various private companies and government programs provide financial incentives for landowners



to maintain trees on their land. Along with helping to sequester carbon, the mesquite trees help support greater ecological services that may benefit the landowner through increased wildlife habitat. From a rancher's point-of-view, simply storing carbon in the soil increases moisture-holding capacity and can potentially smooth out grass and livestock production between good years and drought years, so that cattle need not be sold off in dry years as in the past.

While agriculture is often an emitter of greenhouse gases, ranchers and other Arizona landowners can use practices with mesquite trees to help pull carbon out of the air and fix it into the soil long-term. Since livestock production is associated with roughly 14% of greenhouse gas emissions caused by humans, sequestering carbon from mesquite may be a successful way for ranchers to counteract those emissions; these practices could be used toward attaining "carbon neutral" status for ranchers interested in offsetting greenhouse gas emissions associated with their animals.

Such efforts to fix carbon through mesquite woodlands or agroforestry plots in arid ecosystems may result in the soil organic carbon below ground lasting a longer time in drylands where decomposition is limited. These benefits of carbon sequestration practices from mesquite trees can also increase revenue for private landowners who are interested in preserving land for future generations and/or preserving habitat for conservation purposes. These carbon sequestration efforts are integral for mitigating climate change effects worldwide and resisting further desertification.

There are several management practices that private landowners can follow for increasing carbon sequestration with mesquite. For carbon market programs that involve forestry practices, relevant to mesquite trees, there are three categories of forest management typically recognized. They are reforestation, avoided conversion, or improved forest management. These three scenarios require establishing new tree cover, preventing deforestation, or increasing the amount of carbon per acre, with different levels of management, depending on individual land status. For these situations, the offset that gets credited tends to be the difference found between new forest management practices compared with carbon sequestered under normal business conditions, also referred to as the baseline.

Management techniques for increased agricultural carbon sequestration include five practices farmers can focus on; these will keep roots underground all year.

- Conservation tillage
- Adapting livestock to provide ecological services
- Crop diversification
- Increased nitrogen efficiency
- Crop rotation

When some of these practices are newly applied to mesquite grasslands and woodlands, they make enrollment in carbon market programs possible. Programs—private vs governmental—may vary in their certification protocols and measurement methodologies, but all share the same goals: to slow down climate change and offer food producers a modicum of yield stability in forage, livestock, and wildlife productivity that they otherwise might not have achieved.

The means for measuring carbon sequestration and emissions offsets vary depending on the certification and program type. Colorado State University, with assistance from the USDA, has designed free tools for farmers and other landowners called COMET-farm and COMET-planner. These online resources help ranchers/farmers to quantify greenhouse gas emissions and carbon sequestration related to each unique land situation. The methodologies of these programs are in line with the national US Greenhouse Gas Inventory. The Cool Farm Tool is another resource that farmers and ranchers can use to evaluate greenhouse gas emissions involved with their operation along with the Sustainable Agriculture Network (SAN)/Rainforest Alliance food certification using the included climate module.

The USDA Forest Service provides access to additional resources to help landowners assess carbon sequestrations and greenhouse gas emissions. The Forest Service can help estimate carbon data using remote sensing technology and also has also created a Forest Vegetation Simulator that lets landowners estimate changes in carbon stock (approved by the American Carbon Registry), among other tools available. Various agricultural carbon market programs measure carbon data in a number of ways—these methods include satellite data, computer modeling, AI-enhanced remote sensing, farmer uploaded data, third-party verifications, and soil sampling. A third party is often needed to verify the carbon offsets, and once verified, data can be added to a carbon registry and sold to a buyer on voluntary carbon markets. Four carbon registries that could be used to register carbon offsets are Verra Registry, American Carbon Registry, Climate Action Reserve, and The Gold Standard.

Private landowners can use mesquite trees to increase carbon sequestration on their lands and benefit financially, with a myriad of options on how to achieve this. Resources exist to help landowners and ranchers create long-term management plans to increase carbon sequestration and evaluate how changes in their operations would affect carbon and see how they can benefit financially from sequestration in the long run. These carbon credit options help landowners benefit from increasing sustainable practices in ways that can align with their business interests.

Private landowners and city planners should be encouraged to use mesquite trees in urban landscapes. The mesquite offers much-needed shade, thus reducing the heat-island effect in many cities.

AFTERWORD

Opportunities

This brief overview of livelihoods available to mesquite artisans in Mexico and the US can be highlighted in the following manner:

- There are at least a dozen revenue streams for rural residents of desert regions that can be gained through managing mesquite-dominated vegetation to generate value-added products.
- The demand for these products is growing rapidly, implying that more jobs and higher salaries per year are likely, as long as mesquite resources are better managed.
- Apprenticeships and advanced training can increase income greatly if the quality of the saleable product also increases.
- Many rural residents already have the commensurate skills for opening a start-up mesquite business, but have not considered that mesquite products can offer them good income and artistic satisfaction.
- Better management of mesquite is desperately needed to slow climate change, reduce fire risk, stabilize livestock production in times of drought, and enhance habitat for wildlife and honeybees.
- Bilingual training centers urgently need funding to lift mesquite artisans out of poverty and protect the environment.

We wish to emphasize that even if mesquite species happen to increase in density and spread with climate change, they still need to be managed sustainably. That said, there is no reason that many more livelihoods can not be generated from responsible management of mesquite than in the past. With the current water crises in the Rio Colorado and Rio Grande watersheds putting additional pressure for farmers to use less water per acre or hectare, or else let arable lands go fallow, mesquite may become one solution that will keep those lands from becoming "dust bowls".

We welcome you to join the club of "Mesquiteros" or "Mesquiteers" who value this tree and delight in its many gifts!

BORDERLANDS RESTORATION NETWORK

COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
Southwest Center

Arizona Institute for Resilient Environments & Societies