Multiple Benefits of Arid Land Agroforestry Home Gardens and Riparian Ecosystems[1]

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ABSTRACT: Many products are obtained from home gardens, and a variety of products are obtained from, and uses made of, riparian ecosystems in the arid regions of the southwestern United States and northwestern Mexico. Home gardens yield fruits and nuts, forage and fodder, poles and posts, firewood, vegetable crops, and flowers for consumption in the home or sale; the trees also provide shade for people, their homes, and their livestock. Riparian ecosystems are habitats for wildlife, are grazed by livestock, provide raw materials for wood products, are areas for fishing, bird-watching, picnicking and camping, and at lower elevations are used to grow maize, barely, and other agricultural crops.

Introduction

A wide range of agroforestry combinations are found in the arid regions of the southwestern United States and northwestern Mexico. For convenience, these agroforestry combinations can be grouped into windbreak plantings; alley cropping, home gardens and other plantings of trees, shrubs, and agricultural crops; riparian buffer strips; and silvopastoralism. However, there is a considerable overlap in the products obtained from, and the uses made of, these agroforestry combinations. All of the combinations are multipurpose in character, and have a combination of production and protection functions (Ffolliott and Brooks 1995, Ffolliott et al. 1996). While the production of food, energy, raw materials, and cash outputs is often stressed, the importance of these agroforestry combinations' environmental benefits and sustainability cannot be overlooked.

The multiple benefits of two of these agroforestry combinations - home gardens and riparian ecosystems - are reviewed in this paper. Topics covered include descriptions of the salient characteristics of the two combinations, and the products obtained from, and the uses made of, them.

Home Gardens

Home gardens are not considered to be an important form of temperate agroforestry by some people. Rather, it is often thought that home gardens are more generally represented as a tropical agroforestry system where woody plants and agricultural crops are found in diverse arrays adjacent to people's dwellings (Gordon et al. 1997). However, planting of home gardens has a long tradition in the southwestern United States and northwestern Mexico. Unfortunately, the varieties and extent of home gardens are largely unknown, although this type of agroforestry represents a significant land-use practice.

Home gardens are found in close proximity to people's homes or communities. Therefore, home gardens in the southwestern United States are mostly privately owned and maintained, with the home owner obtaining the derived benefits. Home gardens in northwestern Mexico are grown on ejido and communal lands for the most part. Ejidatarios do not own their land, the government does; however, the nature of home gardens is largely left to the ejidatarios. Small numbers of people own the communal lands in northwestern Mexico.

Characteristics

Home gardens of a diversity of trees, shrubs, vines, and herbaceous plants yield vegetable crops, fruits and nuts, forage and fodder, poles and posts, firewood, and flowers for consumption in the home or sale; the trees also provide shade for people, their homes, and their livestock (Ffolliott and Brooks 1995, Ffolliott et al. 1996). Home gardens are most commonly planted in blocks, rows (alley cropping), or random arrangements on, or adjacent to, homesteads and communities.

Double-cropping is occasionally possible because of the bimodal (winter-early spring and summer-early fall) distribution of annual rainfall in the region (Bandolin and Fisher 1991). However, water is limiting in most cases, constraining the assemblages of plants in home gardens to more drought-tolerant species. A greater, more diverse variety of plant species can often be considered than would otherwise be possible (because of inadequate rainfall) by planting home gardens in concert with water

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harvesting and water spreading methods on sites suitable to the implementation of these water supply systems (Karpiscak et al. 1984, Fowler and Ffolliott 1986). Catchments store the collected water for later distribution to crops when rainfall is insufficient. On other sites, wastewater from municipalities' sewage treatment facilities has been used to irrigate home gardens to sustain their production in periods of water shortages (Wilson 1998). Agricultural crops that are least affected by contact with treated wastewater are planted in the wetlands maintained with this effluent.

Products

In general, the products of home gardens in the southwestern United States and northwestern Mexico, and elsewhere, are obtained from a tree layer at the upper levels of the gardens, a herbaceous layer near, on, or in the ground, an intermediate shrub or vine layer, or combinations thereof.

Benefits obtained from the tree layers of home gardens in the region depend on whether the trees are intentionally planted in home gardens for their products, or whether the owner simply takes advantage of the products available from naturally occurring trees. Apple, peach, orange, and other fruit trees are planted in random arrangements or rows in cooler environments, while mango, papaya, and banana trees are grown in warmer climates. Indigenous or introduced pine trees of varying species are occasionally planted on the perimeters of home gardens to protect the "interior crops" from desiccating winds and blowing dust. Christmas trees are also a component of some home gardens. Poplar, willow, and other hardwoods planted often for aesthetic purposes can also yield fodder for livestock.

Home owners and farmers, at times, underplant scattered oak, juniper and pinyon, mesquite, and cottonwood, and ironwood trees growing naturally with food and forage crops that are able to survive and thrive in rainfed conditions. When this is the case, the tree layer provides occasional (although not always sustainable) sources of fuelwood and fenceposts, construction poles, and fruits and nuts (acorns, juniper berries and pinyon nuts, mesquite pods) for mostly household use. Honey, especially mesquite honey, is another product of value which often generates additional family income. Processing of saleable products for small cottage industries also occurs; examples include cutting juniper for furniture and book ends, lamp bases, or other novelty items; using the trunks and larger branches of mesquite for cabinetry; hand-crafting of kachinas from cottonwood trees (often the roots) by "traditional" Hopi carvers; and carving ironwood and other hardwood species into figurines.

Cereals (wheat, maize, barley, sorghum), legumes (beans and peas, peanuts, soybeans), forages (alfalfa, clovers, a variety of forage grasses), root crops (potatoes, sweetpotatoes, beets, onions, radishes), stem and leaf crops (cabbage, broccoli, celery, cauliflower), and fruit and seed vegetables (tomatoes, peppers, squashes, melons, pumpkins) are grown in varying combinations in the herbaceous layers of home gardens in both the southwestern United States and northwestern Mexico. The nature of these combinations of produce is dictated by the length of the growing season, temperature regimes, fertility characteristics and water-holding capabilities of the soil, whether the crops will be rainfed or irrigated, and personal preference. The produce obtained is either consumed in the household or sold in a local (often roadside) marketplace.

Another commonly obtain product of the herbaceous layer are flowers (carnations, lilies, roses) that are cut or potted for the home or sale. The flowers are grown in varying intermixtures or alternating rows with vegetable crops. Herbaceous plants grown for herbal markets, and gourds (Lagenaria spp.) that are carved into finished products for mail-order sale, are still other cash crops obtained from herbaceous layers.

The intermediate layer, not always a component of home gardens in the region, can include intentionally planted or naturally growing shrubs of value, grapes, or small pear- or plum-bearing trees. Of special note are jojoba (Simmindsia chinensis) and guayule (Parthenium argentatum), two shrubs grown more commonly in the homes gardens of northwestern Mexico. Jojoba seeds contain about 50 percent oil similar to sperm whale oil, while guayule is a rubber-producing shrub. Grapes, when grown in intermediate layers, are varieties of table (or occasionally wine) grapes for mostly home consumption.

A variation of the "typical home gardens" is found in northwestern Mexico, where farmers and small ranchers take advantage of the occurrence of "valuable wildings" to increase the benefits obtained from their home gardens. A variety of cereals, legumes, forages, and other vegetable crops are interplanted with naturally growing shrubs whose leaves and other plant parts are collected and processed into usable products for household use or sale in a marketplace (Russo 1990). Among the shrubs with "commercial value" are Mexican oregano (Lippia berlandieri), a shrub whose leaves are used in cooking as a spice; sotol (Dasylirion spp.), from which an alcoholic beverage can be obtained by distillation; candelilla (Euphorbia antisiplylitica), a shrub harvested for the extraction of wax from the stem; and lechuguilla (Agave lechuquilla), that is harvested as a source of fiber. Cactus pears and pads are collected and processed into jams and jellies, and mushrooms might also be collected.

Seeds of trees, shrubs, vines, and herbaceous plants grown in home gardens are sometimes collected, dried, and stored for future use in home gardens or (occasionally) commercial distribution (Russo 1990). There are instances where the production of seeds is a primary function of home gardens, and a source of income to the owner.

Animal products of home gardens in the region include the animals themselves (goats, pigs, poultry), and the products that are derived from animals (milk, cheese, eggs). Once again, these products are either consumed in the household or sold in a marketplace to generate additional family income. Sometimes, the plant and animal components of home gardens intermingle. These two components are separated by live or barbed-wire fencing in other home gardens to protect the growing plants; this is frequently the strategy when goats or pigs are raised.

Riparian Ecosystems

Riparian ecosystems, situated at the interface between terrestrial and aquatic ecosystems, are important to the region because of the diversity of plants and animals found in these wet environments within the arid landscapes. These fragile ecosystems are found along the banks of rivers and ephemeral, intermittent, and perennial streams, and around lakes, ponds, wet meadows. The abruptness and extent of transitions between the terrestrial and aquatic ecosystems tend to be more pronounced and spatially limited in the southwestern United States and northwestern Mexico than in the more humid southeastern United States (Clark and Benforado 1981, Johnson and Lowe 1985). As a consequence, agroforestry opportunities are often more limited than are found elsewhere.

Characteristics

Riparian ecosystems are delineated by soil characteristics and vegetative communities that require free or unbounded water. These systems are representative of ecological sites, or combinations of sites, in which soil moisture is greater than that otherwise available due to water flowing into and through the ecosystems, or due to subsurface seepage (DeBano and Schmidt 1989, Gregory et al. 1989, DeBano and Neary 1996). The excess water results in soil-vegetation habitats that reflect the influence of the excess in soil moisture. The unique features of these soil-vegetation habitats are the differentiating criteria that largely characterize the regions' riparian ecosystems.

Three general riparian ecosystems, delineated largely by elevation and their natural vegetative covers, are recognized in the region (DeBano and Schmidt 1989, Baker et al. 1998). Ecosystems less than 3,500 feet are often characterized by broad alluvial floodplains and terraced bottoms that support relatively high densities of phreatophytes including saltcedar, sycamore, cottonwood, and a variety of paloverdes. Riparian ecosystems between 3,500 and 7,000 feet contain the largest number of plant species and the greatest canopy cover. A variety of willow, cottonwood, ash, and walnut are among the typical phreatophytes found in these systems. Above 7,000 feet, willow, chokecherry, and boxelder are representative phreatophyte species. All three ecosystems have, or potentially can have, species of Carix, Elocharia, Juncus, and Scirpus along their channel systems. Each of these three ecosystems has a potential to provide multiple products and furnish multiple uses that are unique to that riparian situation.

Riparian ecosystems in the southwestern United States, especially those systems found in the higher mountains, are largely in some form of public ownership or control and, therefore, public agencies are responsible for their management and public policy specifies the management orientation. Native Americans also control important riparian ecosystems at the headwaters of some of the major watersheds in the region. Ownership of high-elevation riparian ecosystems in the private sector is relatively limited. A greater proportion of ecosystems in the lower elevations is held in individual or corporate ownership. In northwestern Mexico, the federal or state government manages many of the drainage systems along which highly-valued riparian ecosystems are located. Critical riparian ecosystems are also found on ejido and communal lands.

Products and Uses

In contrast to the management of riparian buffer strips in the eastern regions of the United States, emphasis in the arid land riparian ecosystems of the southwestern United States and northwestern Mexico is placed less on the planting of perennial trees, shrubs, or herbaceous plants and more on managing the naturally regenerated vegetation for one or more of the following benefits. These riparian ecosystems furnish habitats for a variety of wildlife and fish species, including some species that are listed as threatened or endangered; are grazed by livestock (to excess in many instances); yield limited amounts of wood for specialty products (including many of those obtained from home gardens); and provide areas for fishing, bird-watching, picnicking, and camping. Some of the riparian ecosystems at lower elevations in private ownership are used to grow maize, barely, sorghum, and other cereals, and other agricultural crops. Agricultural production extends outward onto the floodplains in many of these instances.

The buffering action afforded by riparian ecosystems trap sediments and filter nutrients originating on adjacent hillslopes; enhance streambank stability and maintain channel integrity; and furnish shade, shelter, and food for livestock, wildlife and fish species, and other aquatic organisms. Interests in management to sustain riparian buffer strips have been growing throughout the United States in recent years, extending from the more humid Northeast, Midwest, and Northwest to the arid regions (Merwin 1997).

Future Opportunities

Home Gardens

Research and developmental trials are needed to improve the design of the "traditional" home gardens common to the region for energy conservation, food products, and a variety of specialty products that could (in theory) be cultivated or collected (Bainbridge 1995, Merwin 1997). In particular, trials are needed to suggest appropriate home garden designs for low income families and farm workers, suburban homes, public facilities and parks, and the increasing numbers of rural ranchettes being constructed on former open rangelands.

Cooperative research on the potentials of arid land agroforestry to improve people's livelihood should be initiated with Native Americans, who have a long history of experience in home gardening (Merwin 1997). An inventory of useful plants, including traditional medicinal plants, and home gardening practices that are appropriate to the region, and their climatic analogs worldwide, would be useful.

Small-scale irrigation systems that meet the requirements of minimal water losses in applications, prevention of site degradation (waterlogging), and sustained economic efficiency would likely expand the planting and cultivation of home gardens. Water harvesting and water spreading methods that provide additional irrigation water on a seasonal basis, or longer periods of time with a storage facility, represent one possibility. Increased use of treated wastewater is another. However, the use of wastewater, regardless of its level of treatment, to irrigate home gardens necessitates continual monitoring to prevent possible contamination of soils and plants, effluents polluting surface water systems, and wastewater percolating to groundwater aquifers.

Riparian Ecosystems

A major management emphasis of riparian ecosystems in the southwestern United States is presently placed on the assessment of the condition of the limited riparian resources, and on the restoration of riparian ecosystems that are dysfunctional and demonstrating a trend toward degradation. With the loss of instream flows comes losses in riparian and aquatic habitats, recreational opportunities, and water quality. Although millions of dollars have been spent in the past for riparian restoration and fish habitat improvement, healthy riparian ecosystems are still being lost at an alarming rate (Baker and Medina 1997, Baker et al. 1998). Fortunately, current research is showing that many of these degraded (but resilient) riparian ecosystems can be restored to a more productive state with relatively little effort and small expenditures.

Trade-offs between livestock grazing, wood cutting, and other types of exploitation on one hand, and wildlife and fish habitats, recreational use, and maintenance of the buffering benefits of riparian ecosystems on the other hand, must be recognized in planning the restoration process. Decisions can then made on the direction that future management and use of the riparian ecosystems will assume.

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