1988 IFOAM Conference Proceedings, UC Santa Cruz, CA.

THE OAKS:

A NEGLECTED MULTIUSE TREE CROP

David A. Bainbridge[1]

INTRODUCTION

A realization of the role agroforestry (agricultural forestry) will play in sustainable agriculture has begun to grow in recent years (Sholto Douglas et al. 1984; Cannell and Jackson 1985). One of the best adapted multiuse trees for temperate region agroforestry systems is the oak, *Quercus* spp. (Bainbridge 1984; Bainbridge 1986a; Bainbridge 1986b). Oaks have been used for thousands of years as a source of food, fodder, fuel, and a surprising variety of other products. Acorns have been eaten in more than 25 countries from Iran to Japan and remain available today in most major American cities at Korean food stores (Kunkel 1984; Bainbridge 1985a). Acorns are eaten and are sold on the market in Korea and North Africa and other areas as well. They are collected by many Native Americans who never abandoned their use and by many oak enthusiasts who have discovered this nutritious nut (Bainbridge 1986c).

The acorns of many species of oaks are sweet and can be eaten raw. The tannic acids in bitter varieties can be leached with water. Acorn oil, very similar to olive oil, can be extracted with little difficulty (Bainbridge 1985a). This oil has been used in several regions as a cooking oil. In addition to the "grain that grows on trees" and cooking oil, the oaks also provide fodder; fuel wood; timber; hardwood; shingles; insulation; food for mushrooms, silkworms, and sugar-producing insects; tanning agents; dyes; and inks.

Interest in the oaks has diminished as the world's oak forests have been eliminated and degraded by overgrazing and over cutting (Bainbridge 1985b). Decreasing interest in oaks has been encouraged by the nature of academic research (short term); the time required for some oaks to bear acorns (five to ten years); and the bias of most Western foresters against hardwoods in general and multiuse tree crops in particular. This decline has been exacerbated by the continuing neglect of the external costs of annual crop production due to erosion, water pollution, environmental contamination with toxic materials and synthetic fertilizers, and excessive energy use (Bainbridge 1983; Lockeretz 1983; Pimentel 1980). Activity has also been dampened by the errant belief that oaks are incredibly slow growing--when in fact some species will grow more than 3 feet (1 meter) per year.

The research that has been done on oaks is little known in the United States because it has appeared in foreign journals (Spanish, Korean, or Russian) which have very limited distribution. Yet I am increasingly convinced that J. Russell Smith (1950) was correct when he praised the oak as one of the most promising of all tree crops.

Quercus: The Oaks

There are more than 500 species of oaks from which to choose. Among these are trees that tolerate extreme aridity, salinity, alkalinity, flooding, and severe heat and cold. Many species develop a deep taproot and are very drought resistant once established. These properties have made them useful for land reclamation purposes (Bradshaw et al. 1980; Schiechtl 1980) and appropriate for use in sustainable agriculture.

Flowering takes place in the spring and

[1] Ecologist, Dry Lands Research Institute, University of California, Riverside, CA 92521, USA.

the acorns mature either at the end of 1 or 2 years, depending on the subgenera. The oaks are wind pollinated and promiscuous, with hybrids common in some regions. Research at the University of Utah has demonstrated that the subgeneras can cross (albeit reluctantly) so virtually any desired traits could conceivably be combined. Most oaks are grown from seed, although some are produced by layering. Grafting is not difficult and seedlings could be topworked with desired cultivars.

Acorn Production

Acorn yield can be very high for some species, up to 6,000 pounds per acre (6700 kg/ha) in a good year, but lower production is more typical and alternate bearing is not uncommon. Single trees have been found producing: a consistent 660 pounds (300 kilograms) of acorns per year, *Q. ilex*; more than 1 ton (900 kilograms) in a full crop year, *Q. lobata*; and, consistently, more than 200 pounds (90 kilograms) per year, *Q. garryana*. Smith (1950) estimated commercial oak orchards yield would probably exceed 1,400 pounds of acorns/acre/year (1,570 kg/ha/y) with selected cultivars.

High acorn production requires reasonably fertile soil and sufficient water but the oaks' deep roots and mycorrhizal associations enable them to yield decent crops under conditions that would prevent annual grains from maturing. With deep taproots and little or no allelopathic action, oaks can and have been intercropped successfully with barley, maize, wheat, and other crops--offering the possibility of increasing total yield from a farm and providing added security in times of adversity when annual crops fail.

Acorns can be grown on marginal lands where little else can be cultivated without expensive inputs and costly environmental impacts. A comparison of soil erosion associated with tree crops versus corn (comparable food value to acorns) is included in Table 1.

Acorns as Food

It appears likely that the acorns from all the oaks are edible and should be tested for flavor and nutritional value. Studies of acorn composition show that the structure of acorn starch falls between that of corn and potatoes. Acorns contain up to 55 mg of Vitamin C per 100g in the raw acorn. Acorns also include Vitamin A, with 180 IU per gm in *Q. phellos*. Twenty-seven grams, or less than 0.10 pounds of these acorns, would meet the suggested daily Vitamin A requirement of 5,000 IU. This could be of considerable importance in very poor areas of the world where vitamin A deficiencies are common. Thorough testing of the full range of oak species may well discover other standouts for these and other vitamins, trace elements, and amino acids. Acorn composition is shown in Table 2.

The acorns from many oaks are edible raw, just as they are harvested. One of these, *Q. mongolica*, is recommended as a nut tree in an early Chinese agricultural text (Sheng Han 1982). I have found some acorns with flavor comparable to the cashew, *Anacardium occidentale* L. Individual trees vary considerably in bitterness and there is a good possibility that individual trees bearing acorns with excellent flavor can be found (Asmus and Bainbridge 1986). Edible acorn varieties once offered for sale in the United States included the Ashworth cultivar of *Q. macrocarpa* and the Lint cultivar of *Q. alba*. Unfortunately, only the Ashworth cultivar is now available, and only as seedlings which may be of little value. Well-developed cultivars with edible acorns are almost certainly waiting to be rediscovered in Europe, China, the Mediterranean, Korea, and the Middle East, and the worldwide search is overdue.

Bitter acorns can be used because the tannin can be leached from them simply by washing them with water. They can also be sweetened with lye, like olives. They were also sweetened by American Indians with iron-rich red earth, wood ashes, and other additives that neutralize the tannic acids. In some cases, bitter acorns have been sweetened simply by steaming or baking (Bainbridge 1984; Wolf 1945; Heizer et al. 1980).

Acorn Drinks

A number of different drinks can be made with acorns and they have been used as a coffee substitute both in Europe and the Americas. *Q. muehlenbergii* was especially favored for this purpose in the Midwestern U.S., while *Q. robur* is used in Europe. From Turkey, *raccahout*, a spiced acorn drink, spread to Europe and was included in the *Larousse Gastronomique* until recently.

Acorn Oil

Acorn oil can be separated from the nuts by boiling, crushing, or pressing. It has been used as a cooking oil in Algeria, Morocco, and parts of the U.S. This oil was also used by the Native Americans of the eastern U.S. as a salve for burns and injuries. Some varieties contain up to 30% oil, comparable to the best olive varieties, and the oil itself is very similar to olive oil. The properties of acorn oil are detailed in Table 3.

Alcohol

Acorns were used to brew alcohol in Europe. Using acorns for alcohol production would depend on the yield characteristics of the trees and the cost of collection and processing.

Oak Leaves

Oak leaves from some species were eaten in the Americas and Asia and used as wrappers for cooking, like corn husks. I have been unable to locate any information on the leaf composition of these species but it is a promising area for research.

Other Edible Products from Oaks

Oaks are also important for two other food products, edible fungi and sugar. The fungi include truffles (retail value of $300/per pound), shitake (retail value about $4.00/per pound), and other mushrooms. One of the very large Japanese food corporations is setting up a large shitake operation near Los Angeles to capitalize on America's growing interest in mushrooms.

The sugar from oaks is more of a curiosity in America but is probably still of some importance in isolated areas of the Middle East. There, scale insects (coccids) excrete a sugar residue which is collected and used in a variety of ways (Thompson 1949).

Fodder

Acorns have been used to feed domesticated animals for thousands of years. Most varieties can be used for 20% of the diet of chickens and other animals with no difficulty. Leached, acorns can be used in higher percentage as a part of a properly balanced diet. Acorns are an essential food for many species of wildlife. In California studies have shown that deer in some areas may rely on acorns for more than 80% of their food in the late fall. Oak leaves are an important fodder in many regions; *Q. semecarpfolia*, for example, is favored in India (Upendranath Kanjilal 1969). Oak trees may be pollarded for ease of harvest and higher productivity.

Firewood

Many of the oaks produce excellent fuelwood and this has been a contributing cause of oak removal. Most of the oak species yield high-quality fuelwood and charcoal. Oak charcoal was an important element in the rise of industry in both England and Europe. Fuelwood yield is typically 2 tons/acre/yr (5t/ha/yr) on a 30-year rotation. Oak for fuel has often been grown as a coppice with standards to yield fuel from the coppice and both timber and acorns from the standards.

Timber

Many of the oaks have very high-quality wood. For several hundred years, oak was a preferred material for shipbuilders in Europe, England, and the U.S. Exports of live oak *Q. virginiana*, were a major source of income for the United States when foreign exchange was urgently needed. The high value of the oak

for shipbuilding led to serious problems of theft from government lands.

Oak wood is still prized because it is hard, tough, durable, and resilient. It is widely used for flooring, veneer, furniture, boats, barrels, and many other products. It is preferred by timber-frame house builders when suitably sized beams are available. More countries should have the wisdom to adopt the 120-to-210-year oak rotations practiced in France (Oswald 1982).

By the time a current oak planting is mature, the world hardwood market will be drastically changed as low-cost hardwoods from the destruction of the tropical rainforests are used up. Ideally, strict reforestation requirements would be required of any country exporting hardwoods to the developed world. This would accomplish two things. First, it would make the native hardwoods in the developed countries more competitive and would make it more economical to invest in oak plantations for long-term rotations. Second, it would provide some protection for the forests and cultures of the hardwood-exporting countries.

The United States should immediately begin an extensive oak-planting program to restore the oak forests. Selection and widespread distribution of high-quality timber and acorn cultivars would do much to repair the damage that has been done by 300 years of neglect and abuse.

Shingles

Some oaks split well and are used to make shingles. *Q. imbricaria* was preferred for this in the Southeast and is known as the shingle oak.

Other Products and Uses

Oaks also provide other valuable products including cork, one of the few natural insulation materials. Cork is also used for bottle stoppers, flooring, and a number of other manufactured items. Cork oak, *Q. suber*, is an important crop in the Mediterranean area and has proven to be well adapted to climate and soils in the western U.S., Australia, and elsewhere. If environmental costs of non-renewable resources were accounted more carefully, cork would probably be grown commercially in these regions.

Oak also provides the leaves for silkworms in China. The wild silkworms, Saturnidae, which feed on oak leaves, produce a tougher, rougher silk than the domesticated silkworm. The Chinese produce about 80% of this *tussah* silk.

CONCLUSION

The factors that once made oaks a holy tree in cultures around the world are finally being realized and appreciated. A serious international effort should be initiated to select, develop, and distribute the most promising species and varieties of oaks. Related research and development of oak and acorn products, processing, and marketing should also be begun. Foresters, farmers, and public and private landowners should begin to consider multipurpose trees such as the oaks in planting and management plans. And finally, scientists and international aid organizations should begin to include research and development programs for oaks in their assistance programs. Emphasis should be placed on the development of varieties and management plans for using oak polycultures--both intercrop and multicrop--designed for long-term sustainability.

ACKNOWLEDGEMENTS

With special thanks to Dana Sowers for her grace under pressure and to Dr. Wes Jarrell for the opportunity to prepare and present this work.

REFERENCES

Asmus, K., and D. Bainbridge. 1986. *Acorn Testers News* 1:1, University of California, Riverside: Dry Lands Research Institute.

Bainbridge, D.A. 1983. Farm accounts, 1982: A very bad year. *Acres: USA* 13(9):2.

———. 1984. The grain that grows on trees. *Mother Earth News*, September/October,80-84.

———. 1985a. *Acorns as food: Oak bibliography* 1, Twain Harte, CA: Sierra Nature Prints.

———. 1985b. The rise of agriculture: A new perspective. *Ambio* 14(3):148-151.

———. 1986a. *Quercus*, a multi-purpose tree for temperate climates. *International Tree Crops Journal* 3(4):291-298.

———. 1986b. Multipurpose tree crops for dry lands. Paper presented at the 2nd International Permaculture Conference, Evergreen State, Olympia, WA.

———. In press. The use of acorns as food in California: Past, present, future. In *Proceedings of the symposium on multiple-use management of California's hardwood resources*, edited by Stanley Sher. Berkeley: Pacific SW Forest and Range Experiment Station.

Bennett, H.H. 1939. *Soil conservation*. New York: McGraw Hill.

Bradshaw, A.D., and M.J. Chadwick. 1980. *The restoration of land*. Berkeley: University of California Press.

Cannell, M.G.R., and J.E. Jackson. 1985. Attributes of trees as crop plants. Institute of Terrestrial Ecology, National Environmental Research Covneil, Huntington, England.

Heizer, R.F., and A.B. Elasasser. 1980. *The natural world of the California Indian*. Berkeley: University of California Press.

Kunkel, G. 1984. *Plants for human consumption: An annotated checklist of the edible phanerograms and ferns*. Koenigstein: Koeltz Scientific Books.

Lockeretz, W. 1983. *Environmentally sound agriculture*. NY: Prager.

Oswald, H. 1982. Silviculture of oak and beech high forests in France. In *Broad Leaves in Britain*, edited by D.C. Malcolm and J. Evans. Wrecclesham, England: Institute of Chartered Foresters.

Pimentel, D., et al. 1980. *Environmental and social costs of pesticides*. Oikos 34:126-140.

Scheichtl, H. 1980. *Bioengineering for land reclamation and conservation*. Edmonton: University of Alberta Press.

Sheng Han, S. 1982. *Ch'i Min Yao Shu*. Peking: Science Press.

Sholto Douglas, J., and R.A. de J. Hart. 1984. *Forest farming*. London: ITDG Publications.

Smith, J.R. 1950. *Tree crops*. Reprint, 1977. Old Greenwich, CT: Devin Adair.

Thompson, R.C. 1949. *A dictionary of Assyrian botany*. London: British Academy.

Upendranath Kanjilal, R.B. 1969. *Forest flora of Chakrata*. Delhi: Dehra Dun and Saharanpur Divisions.

Wolf, C.B. 1945. *California wild tree crops*. Orange County: Rancho Santa Ana Botanic Garden.

Table 1: Soil Erosion for Corn vs. Equivalent Tree Crop

Land use	Slope (%)	Soil loss (tons/acre/yr)
Continuous corn crop, Missouri	4	20.000
Continous corn crop, Wisconsin	16	89.000
Corn, contour furrows, Iowa	10	24.000
Forest, North Carolina	10	00.002

Adapted from: Bennett, p. 993 (1939).

Table 2: Acorn Composition: 18 Species

Component	Range (%)		
Protein	2.3	-	8.6
Fat	1.1	-	31.3
Carbohydrate	32.7	-	89.7
Tannin	0.1	-	8.8
KCAL/100 gms	265.0	-	577.0

Source: Bainbridge (1985a).

Table 3: Composition and Characteristics of Acorn Oil

	Q. ilex	*Q. incana*	*Q. glauca*	*Q. palustris*	Olive Oil
Specific gravity at 25°C	0.9086	0.9081	0.9062	----	0.918(15°C)
Refractive index at 25°C	1.4701	1.4576	1.4660	1.4647	1.4679(40°C)
Saponification value	189.05	192.20	185.13	193.20	189.7
Olieic acids	57.05	82.00	55.25	----	84.4
Palmatic acids	12.40	17.10	10.65	----	6.9
Linoleic acids	30.50	----	32.50	----	4.6
Iodine value	98.80	81.50	99.55	----	81.1
Flash point	----	----	----	320°C	250°C

Source: Bainbridge (1985a).