

Herbs in American Fields: A Horticultural Perspective of Herb and Medicinal Plant Production in the United States, 1903 to 2003

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Herbs, plants that represent a broad group of aromatic and medicinal species, are relatively minor horticultural crops in the U.S. compared with other garden and field species. Yet, human societies have developed an intimate relationship with herbs, making these plants more important than mere acreage or crop production reports would indicate. Anyone doubting the significance of these plants need only to think of an apple pie without cinnamon, a pizza without oregano, a headache without aspirin, or a childhood leukemia patient without vincristine to appreciate the ways in which herbs influence the quality of life, providing flavorings, medicines, fragrances, and a host of other substances that delight the senses and cure ailments. Herbs are ornamentals for gardens and landscapes and reservoirs of chemicals to calm and enhance the human spirit. Herbs and herb extracts are a collection of flavorings for our foods and beverages and pharmaceuticals for treatment of our afflictions. Estimates suggest that 75% of the world's population relies on plant-based medicines for primary healthcare and that populations using pharmaceutical drugs obtain about 120 prescription drugs from higher plants (Abelson, 1990). Without herbs and medicinal plants humans would likely exist in a much-reduced state.

Over the past 100 years, herb production in the U.S. has varied considerably, following medical and culinary trends within American society. Generally, commercial production of herbs was strong from 1903 to 1939, declined from 1940 to 1969, and increased from 1970 to today. These changes were influenced by several factors, including the need for plants as medicines, the development of organic chemistry, shifts in population demographics, searches for alternative farm crops, changes in food preferences, activities of the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA), concern for plant diversity, and passage of the Dietary Supplement Health and Education Act of 1994. The total crop land currently devoted to commercial production of herbs and medicinal plants in the U.S. is about 187,000 acres, relatively small compared with crops such as popcorn (337,000 acres), tomatoes (414,000 acres), or peanuts (1,352,000 acres) (USDA, 1999). Because herbs are a minor horticultural crop in the U.S., relatively little research has been done on the production and protection of herbs during the past 100 years and only a minimal amount of production and trade data have been recorded.

A WELL-ROOTED BEGINNING: 1903–1939

At the beginning of the 20th century, many homes had a small culinary herb garden and a number of herb plants were in commercial production in the U.S. Ginseng (*Panax quinquefolius* L.) and goldenseal (*Hydrastis canadensis* L.), medicinal plants native to the eastern woodlands but at the time becoming scarce from over-collection, were cultivated under natural and constructed shade in the eastern half of the country (Fig. 1). Commercial production of peppermint (*Mentha x piperita* L.) and spearmint (*Mentha spicata* L.) for essential oil was entering a second century in the U.S. with over 1700 acres of mint under cultivation in 1911 (Landing, 1969). By 1910, attempts were being made to grow essential oil crops, such as rose geranium (*Pelargonium graveolens* L'Hérit), in Florida and California for use in perfumery (Fox, 1936). The medicinal plant businesses of the Shaker communities, the primary U.S. producers of medicinal plants in the 1800s, were waning, but probably still had over 200 acres of more than 60 species of medicinal plants in production (Fox, 1936). Other medicinal plants in commercial production at the time included wormseed (*Chenopodium ambrosioides* L.) and wormwood (*Artemisia absinthium* L.) (Stockberger, 1915). Commercial production

of culinary herbs was relatively common, making seasonal fresh herbs available at specialty markets in urban centers (Fox, 1936). In rural areas, culinary herbs were likely obtained from home gardens (Fox, 1936) and medicinal plants were gathered locally or purchased from mail order catalogs (Fig. 2). The significance of the herb and spice trade in the U.S. at this time, already 250 years old by the early part of the 20th century, is exemplified by the founding of the American Spice Trade Association (ASTA) in 1907. The ASTA, a group of spice and herb brokers, processors, growers, and allied business people, was formed to provide trade and quality standards for the American herb and spice trade, helping to keep companies in business after the passage of the 1906 Pure Food and Drug Act (McNeill, 2002).

The challenges to successful and profitable cultivation of herbs in the early part of the 20th century were similar to those of today and are listed in a 1915 USDA Farmers' Bulletin as the expense of hiring laborers, the lack of mechanization, the dangers of overproduction, the several years of growth required for many medicinal plants, and the lack of crop production information (Stockberger, 1915). Scientific information on the use and application of herbs in America began in 1931 when Maud Grieve, a fellow of the British Royal Horticultural Society, published *A Modern Herbal* (Grieve, 1931), an extensive volume on the



Fig. 1. West Virginia goldenseal grower, Lee S. Dick, ≈1907. Source: Harding, 1908.

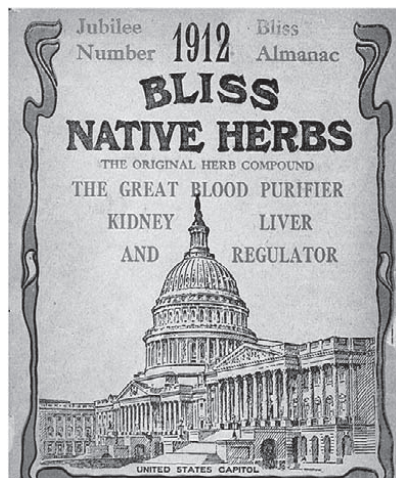


Fig. 2. Cover of mail-order catalog for medicinal herbs.

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Table 1. Medicinal plants suggested for cultivation. Sources: Schneider, 1912; Sievers, 1948, Brevoort, 1998.

1912	1948	1998
Artemisia	Belladonna	Black cohosh
Burdock	Digitalis	Echinacea
Cascara sagrada	Ginseng	Feverfew
Chicory	Goldenseal	Ginkgo
Dandelion	Henbane	Ginseng
Elder	Horehound	Goldenseal
Horehound	Jimson weed	Milk thistle
Jimson weed	Licorice	Red clover
Milkweed	Peppermint	St. John's wort
Red clover	Valerian	Valerian

Table 2. Popular medical practices in the early 1900s.

Conventional medicine: The predecessor of the contemporary medical profession, conventional physicians used plant drugs (such as quinine and morphine), carbolic acid, bloodletting, and mercury-based drugs.

Eclectic medicine: A medicinal practice based primarily on herbal extracts, but which also used conventional medicine treatments.

Herbalism: A medical system that used medicinal plants in whole or extracted form for the treatment of disease.

Homeopathy: Based on the idea that a substance that produces specific symptoms in a healthy person will alleviate the same symptoms produced by a sick person. Homeopathic remedies are highly diluted preparations of plant, animal, or mineral substances.

Thompsonian medicine: Named for founder Samuel Thompson, this practice used specific combinations of herbs and hydrotherapy in treatment of disease. *Lobelia inflata* L., a strong emetic, was the most used herb in this practice.

Table 3. Pharmaceutical discoveries. Source: Achilladelis, 1999 and Scriabine, 1999.

Year	Type of drug	Drug name
1796	Smallpox vaccine	---
1806	Alkaloid	Morphine
1860	Antiseptic	Carbolic acid
1884	Synthetic drug	Phenazone
1911	Chemotherapeutic agent	Arsphenamine
1935	Antibacterial	Sulfamidochrysoidine
1935	Sex hormone	Progesterone
1942	Antibiotic	Penicillin
1942	Antihistamine	Phenbenzamine
1949	Corticosteroid	Hydrocortisone
1975	Recombinant DNA technology	---

nomenclature, use, habitat, description, constituents, biological actions, and cultivation of medicinal plants. Unlike most previous herbals that were based primarily on other herbal texts, *A Modern Herbal* contained information from scientific studies that confirmed the traditional uses of many medicinal plants (Griggs, 1981). This new synthesis of information provided a greater level of understanding and appreciation of herbs and medicinal plants than had been available previously to the general public. In 1933, the Herb Society of America was founded, with the motto of "For Use and for Delight," and began to generate and provide information on the cultivation and use of herbs, becoming the primary entity encouraging the cultivation of these plants in private and public gardens (HSA, 2003).

Herbs suggested for cultivation (Table 1), especially medicinal herbs, have been influenced by the history of medicine and medical practices. In the early 1900s, the practice of medicine in the U.S. was undergoing great change, spurred primarily by political changes in the American Medical Association (AMA). The industrial revolution brought new money to the working class in urban areas and herbal medicine was beginning to be seen as old-fashioned, being replaced by the more glamorously packaged patent medicines and the more fashionable conventional medical treatment (Griggs, 1981). The AMA, founded in 1847, was gaining political power and starting to address the problem of other widely used medical practices, including eclectic medicine, Thompsonian medicine, homeopathy, and herbal medicine (Table 2). The Flexner Report on Medical Education in the U.S. and Canada, sponsored by the AMA and funded by the Carnegie Foundation, was published in 1910 and strongly suggested that plant-based medicines should be abandoned. As noted in the Flexner Report, only conventional drugs should be acceptable as medicines:

"Materia medica, now much shrunken, need concern itself only with the pharmaceutical side, aiming to familiarize the student with drugs of

proved power and the most agreeable and effective forms in which these may be administered" (Flexner, 1910).

The effects of the Flexner Report on plant-based medical practices were tremendous. Within 5 years, most of the eclectic medicine and herbal medicine schools in the U.S. had closed and within 28 years all schools that taught what would now be considered complementary or alternative medicine had closed, leaving only AMA-approved schools in operation (Griggs, 1981).

The pharmaceutical industry was making significant advances in isolation and synthesis of chemical compounds in the 1900s, most notably in the field of organic chemistry. Initial research on textile dyes and coal tar unlocked the potential for development of many new, biologically-active chemical compounds (Achilladelis, 1999; Boussel, et al., 1982). Prewar and wartime efforts to develop and improve drugs led to significant pharmaceutical discoveries between 1935 and 1942, including sulfonamides, sex hormones, antihistamines, and antibiotics (Achilladelis, 1999) (Table 3). The effectiveness of these drugs inspired faith in pharmaceutical extracts as the source for medicines.

Although some plant-based medicinal products, such as Absorbine (first manufactured in 1891), Vicks Vapor Rub (first manufactured in 1924), and Ex-lax (first manufactured in 1908) continued to be used, by the end of the 1930s the public and the medical profession in America viewed medicinal herbs as ineffective. The Pure Food and Drug Act of 1906 required accurate labeling of foods and medicines, but regulations for the content of foods and drugs were not created until the Federal Food, Drug, and Cosmetic Act of 1938, a piece of legislation that set standards for the quality and inspection of foods, required safety testing, and prohibited false claims for drugs (Janssen, 1981). These changes in regulations and medical practices significantly reduced the demand for herbal medicines.

A CHANGE IN TASTES: 1940–1969

While detailed records on horticultural production of culinary, ornamental, and other herbs in the U.S. during the 1940s are scarce, these plants certainly continued to be grown and used by Americans. Instructions on growing herbs were prominent in gardening books (Blair, 1942; Putnam and Cosper, 1942), but minimally noted in farming books (Watts and Watts, 1939), suggesting that most culinary herbs were grown in small plots. Local herb production was geared toward fresh markets, while dried herbs and herb seeds (traded as spices under the guidelines of the ASTA), produced in California, Montana, Oregon, and other agricultural areas of the U.S. (Sievers, 1948), were shipped to urban centers. This effort was helped by the development of metal containers and sterilization (McCormick, 2003). Improvements in transportation, communication, and postharvest operations through the 1940s, 1950s, and 1960s undoubtedly enabled the shipment of fresh culinary herbs across the country and maintained the need for horticultural production of some herb crops.

Although the USDA continued to support the production of drug plants, publishing a Farmers' Bulletin in 1948 titled *Production of Drug and Condiment Plants* (Fig. 3) (Sievers, 1948), the use of medicinal herbs declined throughout the 1940s, 1950s, and early 1960s as antibiotics, vaccinations, improved hygiene, and reliable access to medical treatment became more available. Market demand for medicinal plants suffered further in 1962 with the passage of the Kefauver-Harris Amendments to the Food, Drug, and Cosmetic Act by Congress in response to tragic birth defects induced in the late 1950s by the sedative drug thalidomide in Germany (Achilladelis, 1999). The amendments required that all medicinal materials, including medicinal plants used as drugs, demonstrate effectiveness before being marketed, thus strengthening federal oversight of the drug approval process and giving the FDA a considerable amount of political and regulatory power (Sparks, 2002).

Philosophically, the thalidomide incident justified and reinforced the importance of the regulatory authority of the FDA in the minds of the government and the public even though thalidomide was not a plant extract. The FDA had begun to exercise regulatory power over producers and sellers of herbal medicines during the late 1940s and early 1950s, conducting raids on stores and practitioners that were recommending medical treatments with herbs no longer listed in the official U.S. Pharmacopoeia. Armed with the new authority granted by the Kefauver-Harris Amendments,

Fig. 3. USDA Farmers' Bulletin for production of medicinal herbs.

the FDA required pre-market approval for any substance marketed as a drug, disenfranchising a number of alternative medicine businesses. Herbal medicines sold as over-the-counter (OTC) medicines (available without a physician's prescription) and used in self-treatment were reviewed by the FDA beginning in the early 1970s, with the intention that these materials would be approved for use without further testing if the medicine was generally recognized as safe and effective (GRASE). Those plant materials considered not safe for consumption and those for which no data existed would not be allowed into the market. This system of classifying herbal medicines, however, has created problems because some plant materials generally recognized by the public as an effective treatment of particular afflictions (such as prunes used as a laxative) do not have approval for such use (Blumenthal and Israelsen, 1998).

Market demand for culinary herbs associated with ethnic cuisines increased as soldiers returned home from posts in Europe and Asia at the end of World War II, bringing new food tastes to the U.S. For example, in the decade after World War II, the use of oregano (*Origanum vulgare* L.), the primary herb in pizza sauce, grew 5200% (Spice Advice, 2003). Several factors were responsible for a renewed interest in herbs and medicinal plants in the 1960s, including Julia Child's television show, "The French Chef," which premiered in the U.S. in 1963 and inspired an interest in cooking, particularly French cooking (Leite, 1999). In the late 1960s, the hippies emerged from the Vietnam antiwar movement. The food choices of these flower children emphasized natural products and flavorings, a trend adopted by chefs and incorporated into cookbooks (Leite, 1999).

A FRESH MARKET: 1970–2003

Although commercial interest in American culinary and medicinal herbs grew slowly in the 1970s, interest and consumer demand for herbs increased as the century progressed. At first, consumer interest appeared focused on exotic culinary herbs, but the with opening of China and the promise of alternative medical systems and a growing interest in natural remedies, medicinal herbs gained in importance. An aging population and medical costs opened new horticultural markets for such crops as echinacea (*Echinacea* spp. Moench.), St. John's wort (*Hypericum perforatum* L.), black cohosh (*Cimicifuga racemosa* [L.] Nutt.), flaxseed (*Linum usitatissimum* L.), and goldenseal. The increase in demand for these plants, most of which were collected from the wild, brought worries about over-collection and loss of diversity and led to the initial cultivation of echinacea, black cohosh, and goldenseal. In many instances, these plants were represented as new, high-value crops that could help save small farms.

In the 1970s, considerable demographic changes in the American population became evident as immigrants from Asia and other parts of the world settled in the U.S. following the Immigration Act of 1965. Many of the new immigrants opened ethnic restaurants, serving food from Szechuan, Hunan, Vietnam, Korea, Ethiopia, India, and Thailand, thus globalizing the taste buds of Americans (Leite, 1999) and increasing demand for a wide range of culinary herb species. To meet the demand, production

Production of Drug and Condiment Plants



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U. S. DEPARTMENT OF AGRICULTURE

increased for a wide range of culinary herbs, including exotics, such as chili peppers (*Capsicum annuum* L. var. *annuum*), cilantro (*Coriandrum sativum* L.), garlic chives (*Allium tuberosum* Rottler ex Sprengel), and lemongrass (*Cymbopogon citratus* (DC) Stapf), and the more familiar, such as arugula (*Eruca vesicaria* [L.] Cav. subsp. *sativa* [Miller] Thell.), dill (*Anethum graveolens* L.), marjoram (*Origanum majorana* L.), mint (*Mentha* spp.), rosemary (*Rosmarinus officinalis* L.), sweet basil (*Ocimum basilicum* L.), and tarragon (*Artemisia dracunculus* L.).

At first, herbs were grown in small quantities for specialty markets, but over the years as sales of fresh herbs increased, production increased to meet the larger quantities needed to stock the produce section of supermarkets. For example, basil consumption in the U.S. increased 8-fold from 1960 to 1996 (Davidson and Johnson, 1996). While much of the production increase in herbs occurred locally, larger scale cultivation, frequently in fields, but also in greenhouses and hydroponic systems was begun (Harper, 2002), in such states as California, Florida, North Carolina, and Virginia. Recently, growers have also become interested in domestic production of Chinese medicinal plants to replace imports from China (Craker and Giblette, 2002).

The growing interest in culinary and medicinal herbs in the late 1970s and early 1980s spurred the formation of several scientific organizations (Table 4). In 1982, the American Society for Horticultural Science was petitioned to form the Herbs, Spices, and Medicinal Plants Working Group and the first meeting of the new working group was held, with over 50 members attending, at the society's national meeting in McAllen, Texas, in 1983. In subsequent years, the working group has sponsored or jointly sponsored workshops, conferences, and symposia at national meetings and international congresses. These activities resulted in research publications (Simon et al., 1987) of national and international importance and the development of guidelines for growers (Adams, 2002; Craker and Dinda, 2000; Davis, 1995, 2000; Hålvä and Craker, 1996) and support for the collections of herbs in the USDA–ARS National Germplasm System (Widrechner, 1989, 1991).

To encourage herb cultivation and help distribute research information, a number of publications focusing on herbs began in the 1980s. Of particular interest were *The Business of Herbs*, *The Herbalgram*, and *The Herb, Spice, and Medicinal Plant Digest*, all begun in 1983 and, respectively, offering advice on operating an herbal business, understanding herbal science, and growing herbs (Table 5). *The Herb, Spice, and Medicinal Plant Digest* ceased publication in 1994 and publication of the *Journal of Herbs, Spices and Medicinal Plants*, a professional, refereed journal, began in 1992. A series of symposia on new crops, begun in 1988 (Janick and Simon, 1990), includes a section on culinary and medicinal herbs (Janick and Whipkey, 2002).

Many medicinal herbs, such as ginger and garlic, are used as both flavoring agents and medicine, making regulation of these plant materials challenging. Thus, throughout the latter part of the 20th century, herbal medicines in the U.S. have been considered dietary supplements, a somewhat ambiguous categorization that lies in a regulatory area between

Table 4. Inaugural meetings of herb and medicinal plant research associations.

American Society for Horticultural Science, Medicinal and Aromatic Plant Working Group, 1983, McAllen, Texas.
International Society for Horticultural Science, Medicinal and Aromatic Plant Section, 1982, Hamburg, Germany.
International Congress on Medicinal and Aromatic Plants, 1992, World Congress on Medicinal and Aromatic Plants for Human Welfare, Maastricht, Netherlands.

Table 5. U.S. periodicals related to herb and medicinal plant production.

First published	Title
1947	<i>Economic Botany</i>
1979	<i>Journal of Natural Products</i>
1982	<i>American Herb Association Quarterly Newsletter</i>
1983	<i>Business of Herbs</i>
1983	<i>Herb, Spice and Medicinal Plant Digest</i>
1983	<i>HerbalGram</i>
1988	<i>Herb Companion</i>
1989	<i>Journal of Essential Oil Research</i>
1990	<i>Herbal Connection</i>
1992	<i>Journal of Herbs, Spice and Medicinal Plants</i>

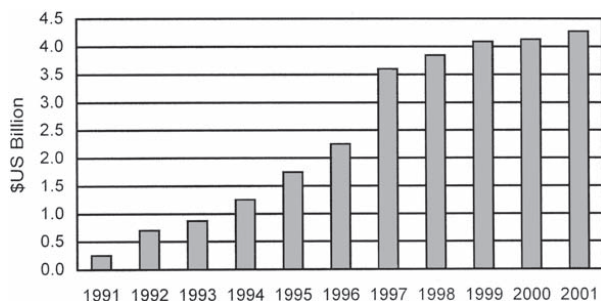


Fig. 4. U.S. market for herbal supplements. Sources: Blumenthal, 2001; Brevoort, 1998; Molyneaux, 2002; Richman and Pier-Hocking, 2002.

foods and drugs. Until 1994, using the term dietary supplements limited FDA regulation of the products, depending on whether the intended use of the supplements was food or drug. Labels on herbal products suggesting medicinal uses would cause herbs to be regulated as drugs, illegal for sale without FDA approval, which would have been a costly, economically unfeasible process for a nonpatentable product (DSIB, 2002; NNFA, 2002). Thus, any herbal products intended for medicinal use could not be labeled as such and any educational information on the products could not be displayed within the vicinity.

The Dietary Supplement Health and Education Act (DSHEA) of 1994 marked a turning point and a rebirth of the medicinal plant industry in the U.S., allowing structure-function claims to be made on labels of herbal products. This new labeling regulation enabled companies to make claims on the effect of an herb in the body. For example, since the passage of DSHEA, companies are permitted to print on an echinacea package "supports a healthy immune system," although statements claiming to cure or treat a specific disease, such as "cures the common cold," are not allowed.

The combination of DSHEA and an increased interest among consumers in natural and holistic healthcare produced tremendous growth in the dietary supplement industry between 1994 and 2001 (Fig. 4). The reborn medicinal herb market in the U.S., however, has experienced growing pains. In 1997 and 1998, several mainstream media outlets (ABC News, 1997; Kluger, 1997; Peterson, 1998) prominently featured stories on medicinal herbs, particularly St. John's wort, echinacea, black cohosh, and ginkgo (*Ginkgo biloba* L.) (Brevoort, 1998). In months subsequent to publication, sales of these herbs increased dramatically (Craker, 1999). For example, sales of St. John's wort increased over 2800% in the year after prominent media coverage of the herb (Brevoort, 1998). Growers producing St. John's wort that year reaped significant profits, leading a number of growers to rush to establish fields of St. John's wort. Unfortunately, because demand for the plant continued to outstrip supply, some processors began to adulterate their St. John's wort products with other plant materials (Kilham, 2003), leaving consumers with ineffective products. Consumers using adulterated products and consumers using pure products, but uninformed on the difference in speed of action between medicinal plants and pharmaceutical drugs, were disappointed by the St. John's wort and did not make repeat purchases. Excited by the initial interest in and demand for St. John's wort, many growers overplanted and became discouraged when the market could not support the increased production.

AMERICAN TRADITIONS: MINT AND GINSENG

Mint and ginseng are two herb crops that have been produced steadily in the U.S. for the past 100 years. These crops, and sometimes parsley, dill, and ginger, are the only herbs that have separate crop headings in the USDA Agricultural Census (all other herbs are listed collectively under the herbs heading) (Table 6) (USDA, 1989, 1994, 1999). In addition, both mint and ginseng have been the subject of numerous USDA and state extension publications (Table 7).

THE MINT INDUSTRY. Peppermint and spearmint are produced for their fragrant, essential oils. The oils are used as flavoring and fragrance agents in such products as gum, candy, and toothpaste (Flikkema, 1999). Commercial mint production in the U.S. began in Massachusetts, in the 1790s and gradually moved westward to New York, Ohio, and Michigan over the next 100 years. Commercial production is now centered in Washington,

Table 6. Herb production in the U.S. Sources: USDA 1989, 1994, and 1999.

Herb	Acres		
	1987	1992	1997
Dill for oil	2,010	1,071	729
Ginger	253	325	281
Ginseng	----	1,505	1,912
Herbs, total	5733	11,077	14,625
Mint for oil	95,623	15,8433	169,847
Total	103,619	172,411	187,394

Table 7. Medicinal plant publications from the USDA and Bureau of the Plant Industry. BPI = Bureau of the Plant Industry Bulletin, USDA Bull = USDA Bulletin, FB = USDA Farmers' Bulletin.

Year	Title and bulletin number
1905	Peppermint. BPI 90
1906	Wild medicinal plants of the United States. BPI 89.
1907	American root drugs. BPI 107.
1909	American medicinal barks. BPI 139.
1911	American medicinal leaves and herbs. BPI 219.
1912	The diseases of ginseng and their control. BPI 250.
1912	Wild volatile oil plants and their economic importance. BPI 235.
1913	American medicinal flowers, fruits, and seeds. USDA Bull 26.
1904	Weeds used in medicine. FB188
1913	The cultivation of American ginseng. FB551
1915	The cultivation of peppermint and spearmint. FB694
1921	Drying crude drugs. FB1231
1929	Peppermint and spearmint as farm crops. FB1555
1930	Ginseng diseases and their control. FB736
1935	Drug plants under cultivation. FB663
1946	Savory herbs: culture and use. FB1977
1948	Mint farming. FB 1988
1948	Production of drug and condiment plants. FB1999
1949	Goldenseal under cultivation. FB613
1953	Ginseng culture. FB1184
1954	Mint farming. FB1988
1978	Growing ginseng. FB 2201

Oregon, Indiana, and Idaho (USDA, 1999). The mints grow best and produce the best oils under warm days (80 °F) and cool nights (60 °F) with at least 13 h of sunshine each day (Langston and Leopold, 1954). Under warm nights, the mint produces an oil containing menthofuran (Bedoukian, 1948), a bitter-tasting constituent in the flower head, and is only useful for export to countries that prefer a bitter-flavored oil. The best quality and highest quantities of essential oil come from the Willamette Valley in Oregon (peppermint) and from the midwestern U.S. (spearmint).

In 1914, two significant innovations occurred in the U.S. mint industry: the development of mechanized planting machines that enabled farmers to increase the amount of land planted to mint and the introduction of portable distilling tubs that allowed farmers to load harvested mint directly into distilling tubs in the field before transporting to the distillation shed. Shortages of mint oil in 1924 and 1925 due to a combination of under-planting and weather conditions caused a sharp price increase in mint oil between 1924 and 1926 (from \$4.50/lb in 1924 to \$32.00/lb in 1926) and sparked significant interest among growers (Fig. 5), leading to mint research and production innovation between 1925 and 1931 (Landing, 1969). During this time, the USDA and experiment stations in Oregon, Michigan, Indiana, and Washington became involved in studies on the cultivation and harvest of mint and the distillation of mint oil and began publishing a relatively steady supply of bulletins, technical studies, and market reports on peppermint and spearmint to inform growers of the latest production techniques and markets (Landing, 1969). In 1928, technological innovations included low-pressure boilers and submerged condensers for distillation, new mechanized planters, and the change of power source in the field from horse to tractor.

Pest control in mint before the advent of synthetic pesticides was a



Fig. 5. Headline grabber for the Western Mint Company, San Francisco. Source: Landing, 1969; Advertisement in *San Francisco Examiner*, Dec. 8, 1927.

problem for mint growers. Some growers experimented with using animals for weed control in mint fields speculating that the animals would eat weed seedlings but would find the aroma of mint undesirable. Sheep did control weed seedlings, but trampled the mint plants, slowing plant growth and making the crop difficult to harvest (Barnett, 1984). Geese were used successfully, eating the weeds without disturbing the mint plants (Marcum, 2001). Since then, preemergence and postemergence pesticides have been developed for use in mint plantings (Berry and Fisher, 1993; Stanger and Ishida, 1996).

The 1940s brought a new understanding of optimum conditions for mint oil production. Allard (1941) demonstrated that a long photoperiod (16 to 18 h) resulted in a significantly higher oil yield than a short photoperiod. Research at Purdue (Ellis et al., 1944) yielded a new, though impractical, method for determining the appropriate harvest time based on free menthol content of the essential oil. Bullis (1948) determined that full bloom was the optimum harvest time for maximum oil production, although harvesting before full bloom is an accepted technique for limiting menthofuran content in the oil (Landing, 1969).

In 1924, verticillium wilt (caused by *Verticillium dahliae*), a major disease of peppermint and scotch mint (*Mentha xgracilis* Sole), was observed on a large mint plantation in Michigan (Landing, 1969) and soon became a significant challenge for peppermint producers in the midwest over the next 25 years (spearmint is not susceptible to verticillium) (Landing, 1969). The disease was spread from field to field in infected rootlets used for planting. *Verticillium*, almost impossible to eliminate from the soil, attacks the vascular system of the plant. The disease is currently controlled by using verticillium-free planting stock and field flaming at the first sign of infection. Verticillium wilt remains a major problem for peppermint and Scotch mint growers, although 'Todd's Mitcham,' 'Refined Murray,' and 'Roberts Mitcham,' along with some other improved cultivars, have some resistance to the disease (CIPM, 2000; Crowe and Ocamb, 2002).

Between 1970 and 1994, peppermint oil production increased 108% and spearmint oil production increased 87% (Pollack, 1995). Total oil production (peppermint + spearmint) today in the U.S. is ≈ 9000 lb with about one-half used domestically (Fig. 6). More peppermint than spearmint is produced in the U.S. because most consumers prefer the taste of peppermint. Both crops have similar cultivation practices and environmental requirements. In the Pacific Northwest, but not the Midwest, spearmint production is limited according to a grower's allotment program. No limits are placed on peppermint production. Growers frequently distill the mint plants and then sell the oil to dealers. To meet the needs of the

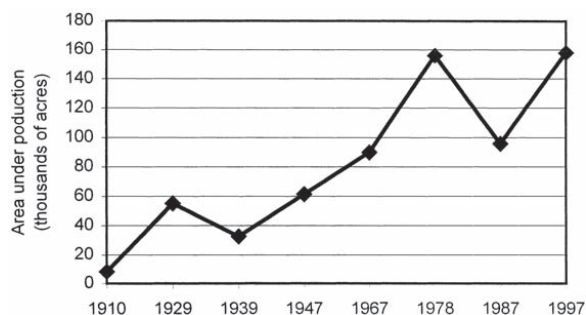


Fig. 6. Mint production in the United States. Sources: Landing, 1969; USDA, 1980, 1989, 1999.

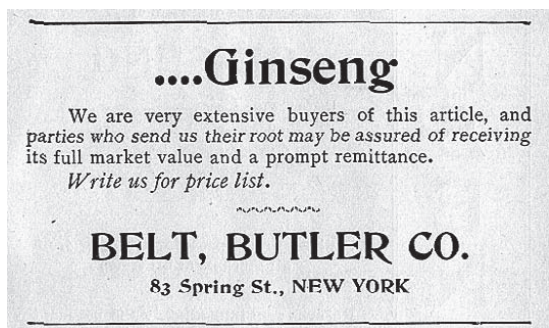


Fig. 7. Notice from ginseng buyer, 1903. Source: Kains, 1903.

customer for a specific flavor (often associated with a manufacturer of toothpaste, candy or other product), dealers blend different batches of oil. Since mint oil can be stored for long periods without decay, the final blend can be a mixture of oil from several different harvests and farms. Genetic resources for peppermint and spearmint are maintained at the USDA-ARS National Clonal Germplasm Repository (NCGR) in Corvallis, Ore. (Chambers and Hummer, 1994).

THE GINSENG INDUSTRY. For over 200 years, ginseng has proven to be a valuable horticultural crop with roots of both cultivated and wild plants being significant export products (Fig. 7). Over 90% of the ginseng produced in the U.S. is shipped to Asian countries where traditional medical practices have long regarded American ginseng (*Panax quinquefolius* L.) as something of a panacea or fountain of youth (Pritts, 1995) with more desirable medicinal properties than the Asian species (*Panax ginseng* C. Meyer). Cultivation in the first part of the 1900s was based in New York, Pennsylvania, Ohio, Indiana, and Wisconsin, but World War II halted trade with China (the primary market for American ginseng), forcing most growers to close their business (Pritts, 1995). Only growers in central Wisconsin were able to wait for the wartime blockade to be removed, leading, at the end of the war, to production of ginseng in the U.S. almost exclusively in Marathon County, Wisc. (USDA, 1999). In 2001, Americans spent about \$170 million on ginseng supplements and on ginseng products, ranging from teas and chewing gum to tinctures, snack chips and smart drinks (supplement-enriched drinks marketed to counter stress) (Taylor, 2002).

Ginseng is a woodland plant that requires shade to grow and takes from five to seven years to reach harvestable size. Growers cultivating ginseng in the early 1900s planted seed in woodlands or open fields under wooden lathe structures to provide the necessary shade (Harding, 1936). Many plantings of the ginseng were destroyed by alternaria blight (*A. panax*), severely limiting cultivation of the crop for several years until experiments with Bordeaux mixture in 1905 and 1906 proved successful in controlling the pathogen (Harding, 1936). Herbicides and fungicides developed in the 1950s and 1960s provided new tools for growers to use against weeds and fungal infections. In the 1980s, polypropylene shade cloth became available and provided growers with an alternative to the high-maintenance wooden lathe shade structures (Eckes, 2003). Some collectors were paid \$500/lb for dried wild ginseng roots in 2002 (Taylor, 2002).

Since the early 1990s, American ginseng growers have faced strong competition in export sales. A shipment of American ginseng seeds sold to Chinese interests in the 1980s was planted in China, replacing some of the American-grown ginseng in Asian markets (Foster, 1992). In ad-

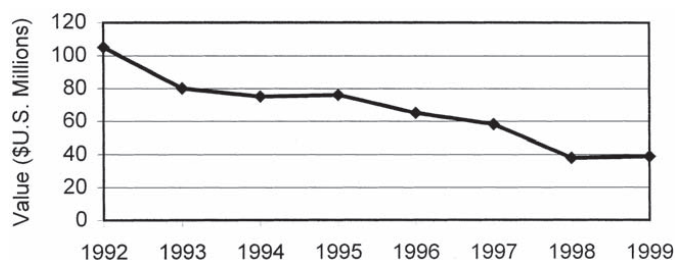


Fig. 8. U.S. exports of ginseng. Source: FAS, 2000.

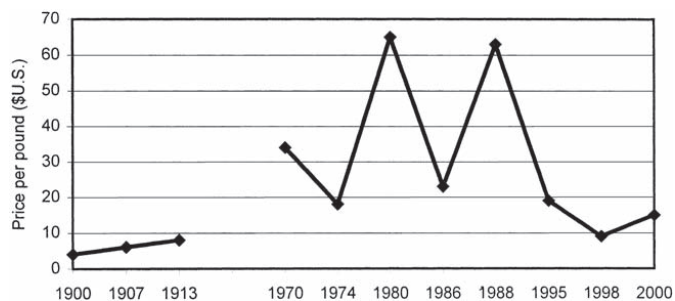


Fig. 9. Prices paid for cultivated ginseng roots. Sources: Harding, 1936; Williams and Duke, 1978; Hsu, 1999.

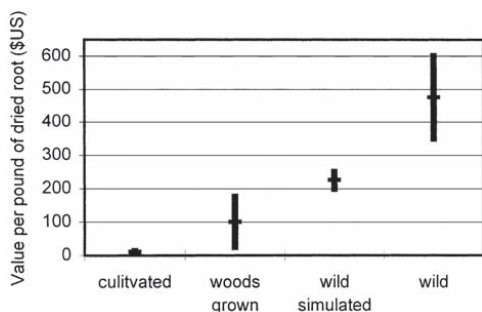


Fig. 10. Prices paid for selected grades of ginseng root. Source: Beyfuss, 1999.

dition, the Canadian government has provided strong technical support for ginseng growers in Canada, significantly boosting ginseng production for export in that country. This foreign competition has, in part, forced a number of Wisconsin growers to abandon ginseng production (Figs. 8 and 9). Indeed, between 1996 and 1999, about half of the 1700 Wisconsin ginseng growers quit the business (Hsu, 1999).

American ginseng is graded according to the production method into cultivated (produced in cultivated beds under artificial shade), woods-grown (grown in cultivated beds in a woodland setting), wild-simulated (grown in uncultivated soil in a woodland setting), and wild (plants collected in the wild). Cultivated ginseng roots look like smooth, bloated relatives of the wrinkled, gnarly wild roots that have traditionally been most valued by Asian consumers. Growers wanting to produce ginseng are now encouraged to produce woods-grown or wild-simulated roots as these cultivation methods produce relatively high-value roots (Beyfuss, 1999) (Fig. 10). Wild and wild-simulated ginseng are valuable crops in Appalachian states. For example, in West Virginia over 8000 lb of wild and wild-simulated ginseng with a total value of almost \$3,000,000 will most likely be harvested in the current season (Cooke, 2003).

CHALLENGES AND PROSPECTS

Centers for herb cultivation in the U.S. have emerged (Fig. 11), yet herb and medicinal plant growers still face a number of challenges, some directly related to common horticultural productivity problems (such as seed germination, weed and pest control, cultivar selection, drought resistance, cold tolerance, specialized seeding and plant maintenance equipment, and germplasm purity), some related to harvest and postharvest problems (such as storage temperatures, drying, pest and rodent control, bioactivity preservation, extraction methodology, and harvest equipment), and some related to markets (such as processing and packaging, phytochemical evaluations, and bioactivity standardization). Horticultural research and information needs for herbs were recently summarized by Small and Catling (1999) as follows:

- Collection, characterization, and protection of germplasm in nature and storage facilities.
- Evaluation of phytochemical attributes of plants and plant extracts.
- Determination of pharmacological activity and safety of plants and plant extracts.

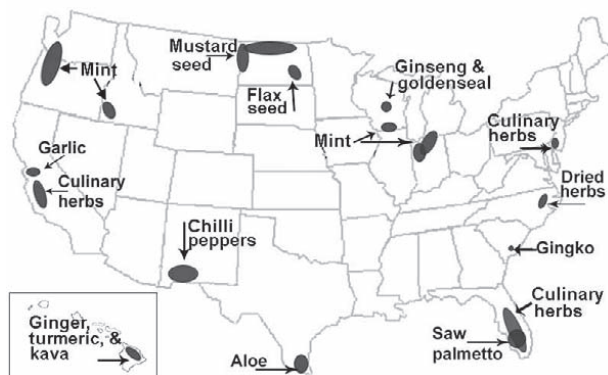


Fig. 11. U.S. production centers of selected culinary and medicinal herbs. Sources: Badaruddin, 2003; Foster, 2003; Kilham, 2003; USDA, 1999.

- Assessment of varieties adapted to local conditions for productivity through plant screening and breeding.
- Investigation of cultural and postharvest requirements, including weed and pest control, soil nutrition, planting densities, packaging, and critical storage temperatures.
- Development of greenhouse cultivation techniques.

Additionally, American herb growers will need to meet standards for Good Agricultural Practices (GAP), Good Collecting Practices (GCPs), and Good Manufacturing Practices (GMPs) currently being promoted at the international level (Harnischfeger, 2000; FAH, 2003; Mathé and Franz, 1999). Such standards, designed to ensure that herbs in international trade are properly identified as to plant material, source, and pre- and postharvest treatments, meet expected quality values for safety and sanitation, and protect biodiversity, have the support of the Medicinal and Aromatic Plant Section of the International Society for Horticultural Science and will most likely become a condition for export and import of herbs.

If market demand for medicinal and culinary herbs is to continue to grow, education within many sectors of society will be necessary to ensure both continued availability and safe and effective use of herbal products (Craker, 2003). For example, consumers must become aware of the benefits and limitations of herbal medicines and the medical profession will need to adopt a more accepting role for medicinal plants. Herbs are neither a cure-all nor miracle product, but instead represent plants that can enhance life by their natural beauty and through the synthesis of particular chemicals.

A conceptual problem with herbal medicines for consumers and the medical profession is the lack of standardization of the bioactive constituents (Natural Products Industry Insider, 2001). As traditionally used, the plant materials and plant extracts can vary considerably in constituent level, creating products above and below recommended dosages. In attempts to overcome this problem, processors have relied upon testing for specific compounds (known as marker compounds) within the plant material. Unfortunately, such tests are expensive and the marker compounds may or may not be the bioactive constituent. In addition, some herbal medicines in the marketplace have been found to be mislabeled, contaminated, and/or adulterated (Natural Products Industry Insider, 2001). Standardization of bioactive constituents and quality processing will undoubtedly be necessary before herbal remedies become mainstream medicines in the U.S.

Coursework on the production, processing, and use of medicinal and aromatic plants, currently available at a handful of schools, will need to be incorporated into the curricula of agricultural colleges for future growers. A number of other countries, including Canada, Germany, Hungary, Turkey, India, New Zealand, and Poland, have devoted significant resources to research and education on production of medicinal and aromatic crops. If the U.S. is to compete with these countries in production of medicinal and aromatic plants, domestic agricultural research entities will need to take the lead in providing technical information to growers while also impressing governmental and nongovernmental funding agencies about the current and potential significance of these crops.

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