CAST
COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY

ISSUE PAPER

NUMBER 6 FEBRUARY 1996

DIVERSIFYING U.S. CROP PRODUCTION

THE *JEFFERSON INITIATIVE* PROPOSES THE KIND OF SUBSTANTIAL, LONG-TERM, AND COORDINATED FRAMEWORK NECESSARY FOR THE CREATION OF A SUCCESSFUL NATIONAL STRATEGIC PROGRAM IN NEW-CROPS DEVELOPMENT.

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SUMMARY

For more than a century, U.S. agriculture has been beset by the pressures of crop price instability. These pressures have caused severe economic problems in rural America. In the past 60 years, federal programs, based on subsidies and acreage reduction, have attempted to stabilize returns to farmers but have failed to check agriculture's eroding economic viability. Moreover, federal crop support programs, at great cost to taxpayers, have served in an unexpected and unplanned way to limit the crop choices available to American agricultural producers.

Public concerns over food safety, commodity program costs, and agricultural sustainability have become important policy issues in the last two decades. Restriction of research funding and crop support payments to major commodity crops has undermined the potential of new crops to alleviate related concerns and pressures. Although support for the development of new and alternative crops has been proposed consistently, publicly funded research has been scarce and fragmented.

The authors of this document propose the *Jefferson Initiative* as a way to focus on new-crops policy reflecting Thomas Jefferson's belief in the critical importance of new crops to American agriculture. The *Jefferson Initiative* would provide leadership in the search for and the development of new crops to improve the sustainability of U.S. agriculture through diversification. Coordinated support for new crops exploration, domestication, production, processing, utilization, and marketing offers tremendous potential benefits to all involved in the agricultural sector—producers, industries, rural communities, and consumers.

INTRODUCTION

United States agriculture is based on crops once considered new[1], and new-crops research was championed by the founding fathers. The United States, despite its large landbase, is the source of only a few economically important crops. Even corn, the major grain of Native Americans, resulted from introductions from Central and South America, as did beans, pumpkins, squash, tomatoes, and potatoes. Colonists introduced wheat, rice, barley, oats, forage, fiber, fruit, and vegetable crops from Europe and Asia. Some native crops such as sunflower and strawberry were developed abroad and reintroduced to American agriculture as profitable new crops. During the 200 years since Jefferson argued the critical importance of new crops to a strong American agriculture, many potentially profitable new crops have been introduced, only to languish, potential benefits unrealized, because public funds necessary for development were lacking. The twentieth century has continued to witness the introduction and/or the development of successful new crops such as soybean—now a major crop of the United States and of the world, avocado and pistachio in California, and pearl millet in the southeastern states. Regrettably, the United States has not taken a long-term, comprehensive, strategic approach to crop diversification.

> THE GREATEST SERVICE WHICH CAN BE RENDERED ANY COUNTRY IS TO ADD A USEFUL PLANT TO ITS CULTURE.
>
> THOMAS JEFFERSON, IN *SERVICES TO MY COUNTRY* (CA. 1800)

The agrarian history of the United States is in many ways a chronicle of the rise and fall of new-crops species. But through a process of introduction, trial, and error, U.S. agriculture has become based on a rather narrow group of crops. Almost 80% of annual row-crop acreage in the United States is planted to wheat, corn, and soybeans. As a result of this concentration, many growers have few alternatives, and low prices on major commodities have a disastrous economic effect.

To stabilize farm income, a system of federal programs including crop subsidies and cropland reduction developed. These programs have been enormously expensive. An estimate of costs from 1978 to 1994 is $291 billion (in 1987 dollars). Adding interest, lost crop wealth opportunities, and multiplier effects will more than double these astronomical costs to U.S. taxpayers (Jolliff, 1996). Payments in turn are distributed unevenly among the various agricultural sectors (Carr, 1992). Yet despite these programs, farm numbers, farm populations, and rural prosperity continue to decline ominously.

As these events have unfolded, a traditional American solution—that of searching for new opportunities through crop diversification—has ceased to be a major part of U.S. agricultural policy. Rather, the focus has been on increasing the yields and decreasing the production costs of traditional crops. The policy of concentrating research and farm support programs on a few major commodities runs counter to repeated recommendations from task forces, individual researchers, and government personnel to create policies encouraging the development of new crops and new products (Table 1). The key constraint seems to be that no single voice speaks for new crops whereas major commodity crops have established constituencies and therefore dedicated support.

Recently, interest in new crops has intensified as the result of a number of interacting forces. The southern corn leaf blight epidemic of 1970 and the worldwide loss of biological diversity have been responsible for an upsurge of interest in germplasm diversity. Over much of the last four decades, low prices for major commodities—punctuated by brief periods of prosperity—have rekindled among growers centuries-old concerns about profitable crop alternatives. The continued strength of the environmental movement has spurred interest in a more sustainable and diversified agriculture while consumer demand for new foods and products has increased as a result of changing demography and health concerns. Finally, economic forces continue to attract innovators and entrepreneurs who see potential in new crops and products.

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[1]*New crops* include established crops not grown commercially in the United States, crops lost to U.S. agriculture, crops of ancient or primitive cultures, underexploited and specialty crops, and as yet undiscovered crops. In this report, *new crops* will refer to established crops not grown in the United States, underexploited crops, and species that remain to be domesticated.

Federal funding for new crops research has been quite minimal in recent years (Jolliff, 1989) and has occurred mainly as an offshoot of political interest in new uses of current commodity crops such as the use of corn for ethanol or for biodegradable plastics. The 1990 Food, Agriculture, Conservation and Trade Act created the Alternative Agricultural Research and Commercialization (AARC) Center to provide funds for the development of new crops, new uses, and new products; since the program's inception in 1992, however, only 15% of available funds have been awarded to new-crops development. Other federal programs involved somewhat in new crops investment are found primarily in the Agricultural Research Service (ARS) or are supported by small grants administered by the Cooperative State Research, Education, and Extension Service (CSREES). The ARS has funded research on alternative oilseeds (National Center for Agricultural Utilization Research, Peoria, Illinois), on developing new industrial oilseeds and natural rubber and latex (Phoenix, Arizona), and on developing kenaf and other fiber crops (Weslaco, Texas).

Table 1. Previous statements on the need for diversification through new-crops development.

Year	Statement and reference
1786	Writings by Thomas Jefferson[a]
1862	Congressional Legislation Establishing U.S. Department of Agriculture (Rasmussen, 1975)[b]
1894	Pepper Report, U.S. Senate Committee on Agriculture (Taylor and Taylor, 1952)
1895	George Report, U.S. Senate Committee on Agriculture (Taylor and Taylor, 1952)
1920s	Need for relief from surpluses (Holmes, 1924; McMillen, 1929)
1935	Chemurgic Movement founded (Barnard, 1937; Benson, 1937)
1957	New and Special Crops Report (Task Group on New and Special Crops, 1957)
1983	Plants: The Potential for Extracts, Protein, Medicines and Other Useful Chemicals (U.S. Congress, 1983)
1984	Development of New Crops: Needs, Procedures, Strategies, and Options (Council for Agricultural Science and Technology, 1984)
1987	New Farm and Forest Products: Responses to Challenges and Opportunities Facing American Agriculture (Sampson et al., 1987)
1988	New Crops and New Farm Products (Congressional Research Service Report)
1989	Growing Industrial Materials: Renewable Resources from Agriculture and Forestry (U.S. Department of Agriculture Task Force Report)
1990	Alternative Opportunities in Agriculture: Expanding Output through Diversification (U.S. Department of Agriculture Economic Research Service Report #633)
1991	Agricultural Commodities as Industrial Raw Materials (Office of Technology Assessment Report)
1992	New Crops, New Uses, New Markets (U.S. Department of Agriculture, 1992)

[a]Letter by Jefferson to William Drayton.

[b]New crops a primary purpose of the new USDA in legislation signed by Abraham Lincoln on May 15, 1862.

Current state research efforts in the area of new crops have been scattered and fragmentary and have tended towards the short term as funding priorities have shifted. Support from agricultural experiment stations in all states has declined greatly as these institutions have focused on basic research and biotechnology funded by national grants programs and private industries. A number of states (Colorado, Indiana, Kansas, Minnesota, Mississippi, North Dakota, and Oregon) have small programs specializing in new crops, but funding is marginal or has been decreased. State departments of agriculture have focused primarily on commodity crops. A national organization, the Association for the Advancement of Industrial Crops (AAIC), was formed in 1988 to promote new nonfood crops. Small programs in private foundations are involved in alternative crop agriculture.

Occasionally, private companies are interested in a new crop as an opportunity; typically, however, they take the cautious approach of waiting until someone else develops the acreage before they commit company resources. The seed industry is reluctant to put resources into new-crops development and prefers to devote breeding efforts to major crops.

Nonetheless, interest in new crops remains high in the research community and among many farmers who actively seek new crops despite the fact that initial risks can be high—especially in the absence of research and development support. Industry, especially the processing sector, often has an interest in new crops, but only if public funding can raise production above a certain threshold. Other governments have recognized this barrier and have provided sufficient funding to help boost new-crops production to levels required to obtain

industry participation. Canada successfully undertook this strategy with canola, and the European Community now is providing substantially increased funding for the development of several alternative crops, with an emphasis on industrial crops and biodiesel fuels. For the period 1995 to 1998, the European Community has budgeted $200 million for research on industrial crops and the Dutch government alone plans to spend $50 million over the same time period on alternative oil seeds (Capelle, 1996).

Despite the successes of a number of new crops in the United States and abroad and despite increased grower and researcher interest, there is no concerted U.S. national policy focused on the introduction, development, and commercialization of new crops. Because of the complexity of new-crops development, rapid progress is difficult, and the path to success for each new crop is neither simple nor easy. The development of crops was a process perfected by primitive peoples over untold generations of prehistory. New-crops development is a process that cannot be achieved in a few years, or during the attention span of most funding agencies.

There are other roadblocks to new-crops development that are created by federal policies and politics. Because federal programs such as crop support payments, production loans and crop insurance, and technical advice are limited to traditional crops, they represent a strong disincentive for farmers considering the risks and benefits of the production of new crops. Support for new crops is fragmented and is not a priority for the traditional commodity groups commonly influencing federal policy. Clearly, initial stages in the development of new crops require various forms of federal and state support and intervention (Jolliff and Snapp, 1988). The Canadian government's methodical research and development program for low-erucic-acid rapeseed (canola) has provided a dramatic model of what is needed and what can be accomplished (Busch et al., 1994).

To capture the benefits of new crops in American agriculture, a coordinated national policy that encourages and supports new-crops research and development programs should be created. This policy should foster regional and national cooperative efforts between farmers, industrialists, and researchers in fields as diverse as agronomy, botany, economics, food, nutrition and health, industrial engineering, and natural products chemistry. The consensus among new-crops researchers is that a number of alternative crops will be successful, and some will be extremely successful; but the winners will depend on the mix of market acceptability, research information, income incentive, and enthusiastic and persistent crop champions. Federal government support of new-crops programs would be a wise and long overdue economic investment in the future.

The Value of New Crops

New crops offer U.S. agriculture many potential benefits for producers, rural communities, and industry. The soybean, for instance, contributed more than $500 billion to the U.S. economy from 1925 through 1985. New crops offer alternative means of increasing farm income by diversifying products, hedging risks, expanding markets, increasing exports, decreasing imports, improving human and livestock diets, and creating new industries based on renewable agricultural resources. New crops also can spur economic development in rural areas by creating local, rural based industries such as processing and packaging and by providing general economic stability. New crops currently serve the strategic interests of the nation by providing domestic sources for imported materials and by providing substitutes for petroleum based products. Promotion of new grain crops in the United States also would serve as a form of world food security because many of the preferred cereal grains, e.g., millet and teff, in food deficit areas such as Africa are not grown widely in the United States. The exploitation of crops that can be grown for fuel, fiber, and a wide array of industrial products would help decrease U.S. reliance on imports, decrease acreage devoted to feed grains in surplus, strengthen the economic base for American farmers, and promote new sustainable industries based on renewable resources.

New Crops for Diversification

Major benefits stem from the diversification of cropping systems. Those systems involving continuous crops or even two crops, e.g., the corn-soybean rotation dominating the Corn Belt, have serious limitations. Such rotations suffer from pest buildups, which necessitate increased reliance on pesticides, which can have a detrimental environmental impact. Diversified crop rota-

tions, which occur typically with new-crops introductions, can limit the impact of pests and can provide other benefits to improve sustainability of farming systems.

Some new crops—winter canola for example—can offer excellent winter-time erosion control. When several crops are in production, each with different planting and harvest dates, the economic impact of weather extremes and disease epidemics is diminished and the demand for labor and equipment spread out. Both factors can improve farm efficiency. Finally, one of the major benefits of diversification is income stability in the face of low prices due to oversupply of a single commodity.

New Crops for New Industries

Although some new crops will substitute for current crops in the marketplace, many new crops will have little or no displacement effect on current commodities. Nonfood industrial crops can serve as a renewable resource base for domestic and export market needs by replacing petroleum based products or other imports (U.S. Department of Agriculture, 1992). Potential new industrial uses include biofuels; lubricants; industrial chemicals; raw materials such as medium-chain, hydroxy, epoxy, and long-chain fatty acids; waxes; and rubber. Promising candidates include crambe, cuphea, guayule, jojoba, lesquerella, vernonia, meadowfoam, and Stokes aster. New woody and nonwoody fiber crops can be used to manufacture many of the diverse products now being imported.

Converting crop acreage into new industrial crops by decreasing production of major commodities often produced in surplus will decrease the amount of federal commodity support needed and will encourage the expansion of industry. New crops may decrease the importation of numerous crops and materials, many of which are of strategic importance. Examples include natural rubber and latex such as guayule, a number of waxes, resins, vegetable oils, gums, and sources of medium- and long-chain fatty acids. Most grains and oilseeds can be used for a variety of products over time, a fact illustrating the value of a diverse crop resource base.

> NEITHER MY OVERSEERS NOR MANAGER WILL ATTEND PROPERLY TO ANYTHING BUT THE CROPS THEY HAVE USUALLY CULTIVATED; AND, IN SPITE OF ALL I CAN SAY, IF THERE IS THE SMALLEST DISCRETIONARY POWER ALLOWED THEM THEY WILL FILL THE LAND WITH CORN, ALTHOUGH EVEN TO THEMSELVES THERE ARE THE MOST OBVIOUS TRACES OF ITS BANEFUL EFFECTS. I AM RESOLVED, HOWEVER, AS SOON AS IT SHALL BE IN MY POWER TO ATTEND A LITTLE MORE CLOSELY TO MY OWN CONCERNS, TO MAKE THIS CROP YIELD [I.E., GIVE WAY] IN A DEGREE TO OTHER GRAINS, TO PULSES, AND TO GRASSES.
>
> LETTER FROM GEORGE WASHINGTON TO THOMAS JEFFERSON (OCTOBER 4, 1795)

New Crops for Improvements in Diet and Health

New crops represent potential sources of new human foods and livestock feeds with increased digestibility and decreased antidietary factors. New grains and oilseeds—the foundation of swine and poultry feeds—and new forages for ruminants may improve the efficiency of animal agriculture. New medicinal crops could assist in the battle with diseases such as cancer and acquired immunodeficiency syndrome (AIDS). Examples of anticarcinogens include vinblastine and vincristine from *Catharanthus (Vinca) rosea* and Taxol® (paclitaxel) from *Taxus brevifolia*. A number of new plant sources, hopefully effective against human-immunodeficiency virus (HIV) properties, are under investigation.

New Crops for Strengthened Rural Communities

An additional benefit of new-crops development is its effect on rural communities. The most observable benefit may be the development of processing, packaging, and other value-added activities that, to decrease transportation costs, must be based in local agricultural communities. Because new crops by necessity are raised first on relatively small acreages, initial processing can be small-scale, typically with local entrepreneurial input. The increased farm income resulting from the planting of new crops will have other multiplier effects on local communities and will provide opportunities for input suppliers.

NEW-CROPS CASE STUDIES

A study of successful new crops indicates a variety of paths by which introduction and establishment occur. A number of features, however, are common to these paths. New crops usually require various forms of government support, especially funding for research and development in plant breeding, production, product development, and marketing. A number of players and institutions must be involved to solve problems transcending disciplinary boundaries and benefiting from timely efforts. New crops introduction demands dedicated leadership and coordination among various economic sectors including research, production, processing, and marketing. Crop champions are an essential component of all successful new-crops efforts.

Soybean

The soybean was introduced into North America in 1765 but until 1920 was grown primarily for forage. The U.S. Department of Agriculture (USDA) conducted limited testing for decades and consistently failed to recognize the potential of the crop as anything other than a forage. Research from publicly supported agricultural scientists working in collaboration with farmers and private industry was essential—especially the work of public breeders who developed new cultivars from germplasm introduced from China, Japan, and Korea. Major explorations were undertaken by the USDA from 1924 through 1931, after earlier seed collections were lost. Industrial support was essential, and in 1922 the Staley Company built the first major soybean processing facility, in Decatur, Illinois (Hymowitz, 1990). In 1941, soybean acreage harvested for seed exceeded that harvested for forage and greatly increased during World War II and the next two decades.

In 1924, about 5 million bushels (bu) of soybeans were produced in the United States, with yields of 11 bu/acre; in 1994, about 2.6 billion bu were produced on 62 million acres, with yields averaging 42 bu/acre. To bring soybeans from a forage to a crop grown for oil and high-protein meal cost U.S. taxpayers an estimated $5 million from 1912 to 1941; the current annual value of the crop is estimated at more than $13 billion. Had there been no public-private partnerships or integrated efforts at production and marketing, soybeans still might be a minor crop, and many farmers in the United States would forfeit the income opportunity that soybeans now provide.

Canola

The development of canola is one of the great achievements in planned new-crops development and represents a model for the modern introduction and development of new crops (Busch et al., 1994). Because it was considered an essential lubricant, rapeseed was grown first on a few acres on the northern Canadian prairie in 1942, as an emergency war measure. One million pounds (lb) were produced with a yield of 1,000 lb/acre. Although the initial lubricant markets decreased, other uses pushed rapeseed production to more than 4 million acres by 1970, with average yields of 1,123 lb/acre (Downey, 1990).

Canadian and European nutritionists became interested in rapeseed oil because it has a significant fraction of long-chain monoenoic fatty acids. The identification of selections low in erucic acid resulted in the first release of low-erucic rapeseed in 1968. By 1970, nutritionists had demonstrated that the low-erucic rapeseed oil was nutritionally superior, and Canada converted its more than 4 million acres to low-erucic varieties (renamed *canola*) in 2 years. In 1994, there were 14.3 million acres of canola in Canada that were producing an annual value of approximately U.S. $1 billion.

Canola production and consumption is the fastest growing segment of the oilseed industry and is increasing at an annual rate of 8%. Canola production began in the United States in the mid-1980s, and by 1994, U.S. production was 447 million lb on 354,000 acres, with an annual value of $50 million. Expansion of the U.S. canola industry, however, is checked by restrictions on market access, unavailability of appropriate varieties, challenges regarding production, and lack of infrastructure. Limited crushing capacity makes it necessary to transport most U.S. grown canola to Canada for processing. The current annual U.S. consumer demand for more than 400,000 tons of canola oil imports represents a major opportunity for U.S. producers, a demand that could support more than 2 million additional U.S. acres in canola.

NEW-CROPS CASE STUDIES

Pearl Millet

This crop, the world's most important cereal in very hot and very dry climates, is grown as a food grain on almost 100 million acres in Africa and the Indian subcontinent (Andrews et al., 1993). As a result of breeding efforts by Dr. Glenn Burton, a USDA–ARS scientist in Tifton, Georgia, pearl millet was developed as a summer annual forage crop and now is grown on 1.5 million acres in the United States.

Agronomic studies and breeding efforts supported by the U.S. Agency for International Development through the Collaborative Research Support Program and conducted in Nebraska and Kansas have demonstrated that it is a promising grain crop for areas of the United States in which drought, soil type, short season, or excessive heat diminishes the yield potential of sorghum. Also, short-season pearl millet hybrids are a promising double-crop after wheat in the Midwest. Pearl millet is a preferred food grain in Africa and has been proved a superior feed for poultry, swine, and fish. In 1994, a newly developed grain-type pearl millet was planted on more than 15,000 acres in Georgia and Florida for poultry feed.

Kenaf

In the 1940s in the southern United States, kenaf was introduced to replace jute in cordage products. In the 1960s, a screening process led by USDA scientists identified kenaf as the most promising fiber crop from among 500 plant species considered for pulping and papermaking (Kugler, 1990; Taylor, 1993). Although this annual crop was tested successfully in 1977 and demonstrated commercially in 1987 for newsprint manufacture, paper market conditions drove development in other directions. Kenaf is coming into commercial use, with mechanical separation mills operating in Louisiana, Mississippi, and Texas. Stem fibers are being used to manufacture dry formed "instant lawn" mats and, through a New Mexico company, to manufacture printing- and writing-grade papers. Core fibers are being used in animal bedding, poultry litter, adsorbents for oil and chemical spills, and horticultural mixes replacing peatmoss. Current farm gate value is roughly $1 million and is expected to increase substantially in the next few years.

Pistachio

This delectable nut was introduced at the USDA Plant Introduction Station at Chico, California in the 1920s, but little interest in pistachio's potential occurred until the 1970s (Ferguson and Arpaia, 1993). Key developments leading to successful crop commercialization were the selection of a suitable genotype ('Kerman') in 1957, the generation of research information by University of California researchers that was able to establish the suitability of California's Central Valley for production, the development of the Central Valley water project, and a tax structure that made it possible for growers to deduct orchard establishment costs.

The formation of the California Pistachio Association in 1976 levied growers and processors for funds to support production research and to educate growers and processors. The advent of the Iranian Hostage Crisis in 1979 and subsequent embargoes of Iranian pistachio imports helped stabilize U.S. pistachio prices. The pistachio industry now is a major California nut industry, with 74,000 acres planted, an acreage exceeded only by that of almonds or walnuts. In 1995, farm gate value of the crop (147 million lb) was $170 million, with a retail value of approximately $440 million.

Quinoa

This little known Andean pseudograin initially was evaluated in Pennsylvania, where it was eliminated from consideration because of poor adaptability. In 1983, it was reintroduced in Colorado that has an environment similar to that of the Bolivian Altiplano, where the plant originated. Between 1983 and 1987, only $76,000 of taxpayer funds was invested in developing quinoa as a new U.S. crop; yet this investment has yielded a new crop with an estimated value exceeding $5 million in 1995. Interest in quinoa has increased worldwide because of unique starch properties suggesting a number of industrial uses.

Meadowfoam

Meadowfoam is a winter-spring annual wildflower with unique seed oil that is native to northern California and southern Oregon. In the 1950s, USDA scientists discovered that its seed oil had unique properties making it a suitable source of a number of potentially useful deriva-

NEW-CROPS CASE STUDIES

tives. Crop domestication efforts (breeding, agronomy, seed processing, product development, and marketing) have been carried out at Oregon State University in cooperation with the USDA, industry, and private growers, in an effort to provide a potential new crop for the Willamette Valley. In 1995, about 3,000 acres of meadowfoam were in production.

Milkweed

Pods of this native weed were gathered and used as fill for life jackets during World War II, but such efforts were abandoned after the war. Research interest increased in the 1970s, when the crop was suggested as a source of biofuels, but the program was curtailed when the process proved uneconomical. An oil company executive became interested in the potential of milkweed as a fiber crop and founded the Natural Fibers Corporation in 1987 to create a new agricultural industry based on milkweed (renamed syriaca) (Knudsen and Zeller, 1993).

With the aid of federal support from a Small Business Innovation Grant (SBIG), a cooperative USDA grant to the University of Nebraska, and an AARC Center investment, the corporation created a means of using syriaca seed floss as a nonallergenic fill to replace imported duck and goose downs in comforters. Two hundred acres of milkweed now are being grown in Nebraska, and company sales have surpassed $1 million; expansion to 900 acres is expected for 1996. The strategic plan of the company calls for expansion into nonwoven uses such as batting made with other natural and synthetic fibers, as well as yarns, pulps, and papers.

Taxus for Taxol® Production

Between 1960 and 1982, the National Cancer Institute screened 35,000 plant samples for anticancer activity. An anticancer drug registered as Taxol® (paclitaxel) and isolated from the bark of the Pacific yew (*Taxus brevifolia* and other *Taxus* spp.) proved effective for arresting ovarian and metastatic breast cancers and created a tremendous demand for the drug (Piesch et al., 1994).

Taxus brevifolia was found in old-growth forests in the Pacific Northwest, the habitat for many endangered species, but the tree had to be destroyed if the bark was to be extracted. A renewable source thus was needed to meet demand. Subsequently, precursors of paclitaxel were extracted from the needles of many *Taxus* species to produce semisynthetic Taxol®. The drug from this source was approved for use by the U.S. Food and Drug Administration in late 1994. Bristol-Myers Squibb, which was responsible for producing the drug, contracted with a number of companies including the Weyerhaeuser Corporation (Washington) and Zalenka Nursery (Michigan) to provide a renewable source of needles. Twenty to 25 million shrubs now are being cultivated to meet the demand for Taxol®.

THE CASE FOR FEDERAL SUPPORT

America's cropland is a natural resource with the potential to produce renewable wealth, and the entire nation benefits directly or indirectly when a new crop is developed. Because of the complexity of development and the uncertainty regarding what sectors of agriculture and regions of the United States might gain most from investment in development, federal support and leadership are essential to a successful program of new-crops introduction. Many obstacles make it unlikely that individuals can introduce, develop, and commercialize new crops successfully. Three obstacles will be discussed in depth.

1. **The long-term nature of crop introduction.** The aforementioned new-crops case studies indicate that successful new-crops development often is a lengthy process and that 10 to 40 years or longer often are necessary to discover, to domesticate, and to commercialize major new crops successfully. It is the long-term nature of new-crops development that deters the private sector from including it in research and development programs. Nothing can be done without suitable germplasm and plant breeding research that is a long-term activity and must receive government and institutional support in the early stages. Thus, institutions such as the USDA–ARS and state agricultural universities and experiment stations must participate in new-crops development.
2. **High risk.** New-crops introduction, with its high failure rate, is inherently risky, at least over the

short term. Bottlenecks are many and include problems with production, crop adaptability, and, most important, market forces. Because crop adaptation is involved, research must be multiregional. Often the tremendous benefits of success may not accrue to the originator, a fact that deters private sector investment. The geographic regions of environmental and economic adaptation for potential new crops often are unknown at the outset of work on domestication and improvement. For example, wild rice was improved substantially as a new crop in Minnesota, but California subsequently adopted the crop and now dominates production.

3. **Coordination problems.** Growers ordinarily are not interested in new crops without an assured market, and marketers will not handle new crops without an assured supply. Because of this dilemma, an independent and neutral party is needed to bring researchers, growers, processors, and marketers together within and between regions. Furthermore, the successful introduction of new crops involves solving problems that transcend disciplinary boundaries, and coordinating marketing problems that involve both public and private sectors of the economy. Transdisciplinary effort and cooperation are needed that extend well beyond the attempts most current institutions make with multidisciplinary research. For example, the Canadian government changed rail freight rates, created grading standards, invested heavily in production research, and examined the health and safety risks and benefits of canola.

Pathways to New-Crops Development

The authors of this report believe that a successful new-crops policy is essential to the productive capacity and sustainability of U.S. agriculture. New-crops development is in the public interest because of the multiple benefits that may result. Obviously, the competition for limited public resources apportioned to agricultural research is intense and an arena in which established agricultural commodities are well represented and apply strong pressure. The poor record of past attempts to advance new-crops development in the United States suggests that institutional innovation is needed. A consortium of policymakers, researchers, industry representatives, and farmers should be organized to create a permanent voice for new-crops development.

Recommendations for new-crops development have been made regularly for more than a century, but, in spite of these appeals, underinvestment continues at great economic, social, and environmental costs. An effective policy must be based on a reallocation of resources equal to the task. The authors believe that three steps must be taken if this objective is to be accomplished.

New-Crops Development a Primary Goal When USDA Was Established

Be it enacted by the Senate and the House of Representatives of the United States of America in Congress assembled. That there is hereby established at the seat of the Government of the United States a Department of Agriculture, the general designs and duties of which shall be to acquire and to diffuse among the people of the United States useful information on subjects connected with and distribute among the people new and valuable seeds and plants.

The opening section of the legislation establishing the new U.S. Department of Agriculture (May 15, 1862)

Renewing the Original USDA Commitment to New-Crops Development

The authors recommend a renewed focus on one of the primary congressional mandates to the USDA at the time of its establishment in 1861: "to acquire and to diffuse among the people of the United States useful information on subjects connected with and distribute among the people new and valuable seeds and plants." The authors also encourage the USDA (1) to examine how better to support new-crops development through policies and programs and (2) to request additional funding from Congress for new-crops development and/or to redirect current funding into this area.

To more strongly encourage USDA's efforts in

new-crops development, the authors suggest including under research priorities legislative language specifically supporting new crops:

> *It shall be national policy to diversify agriculture by the development of new crops, thereby providing farmers with more crop options, strengthening the renewable resource base, and stimulating additional rural economic development.*

Developing Incentives for Adoption of New Crops

Incentives would include but not be restricted to developing crop insurance for new crops, providing guaranteed loans for designated new crops, allowing experimental new crops to be grown on idled land, exclusively releasing new publicly supported cultivars to individuals and to organizations devoted to new crops, and creating a system of grants for farmers and small businesses interested in testing specific new crops.

Creating Institutional Innovation through a Jefferson Initiative

To create a coordinated development effort for new crops, the authors propose the creation of a new-crops initiative to be called the *Jefferson Initiative* in honor of the strong personal commitment of Thomas Jefferson to improving American agriculture through the development of new crops. The Jefferson Initiative would become the focal program for new-crops development and would serve as an umbrella for many types of public-private partnerships aimed at commercialization.

An innovative new research and development entity is needed to provide the critical mass of talent and resources needed to boost new crops to a self-sustaining level and to catalyze the Jefferson Initiative. It is proposed that this entity be called *The Thomas Jefferson Institute for Crop Diversification* and that it be established with a progressive vision of how science can be employed on behalf of agriculture. The Jefferson Institute, comprised of a national research and development center and 8 to 10 cooperating regional centers (Figure 1), would employ interdisciplinary teams to address the interlocking problems of breeding, production, utilization, and marketing.

The benefit of a national center is that it would have the capacity to achieve major new-crops introductions, to develop public awareness and interest, and to engage the participation of many partners, including ma-

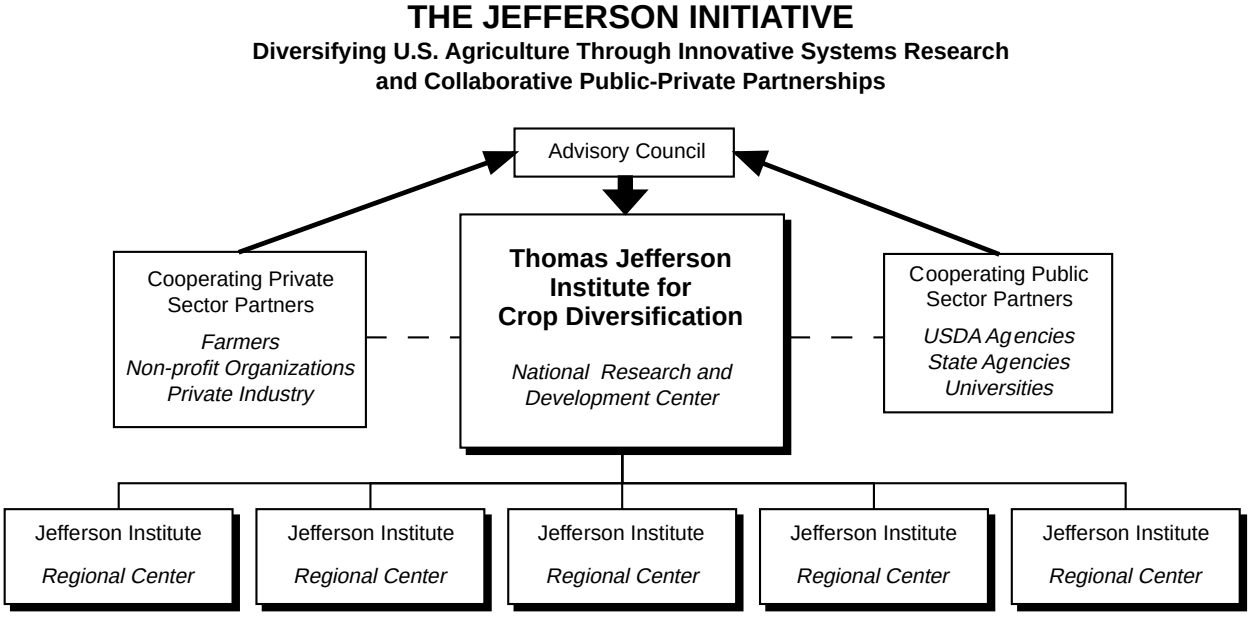

Figure 1. The Jefferson Initiative to diversify crop production in the United States would be catalyzed by the Thomas Jefferson Institute, comprised of a national research and development center and cooperating regional centers. The Institute would stimulate partnerships with both public and private sector collaborators through grants and contracts derived from federal funding.

jor agribusiness firms. Regional centers would complement the national center by allowing optimal testing and development of varieties adapted to each region; by obtaining more complete involvement of researchers, extension specialists, and other agricultural experts across the country; and by developing the localized link to farmers, processors, and marketers that is needed to establish new crops in each region.

> WE ARE PROBABLY FAR FROM POSSESSING, AS YET, ALL THE [CROPS] FOR WHICH NATURE HAS FITTED OUR COUNTRY. TO FIND OUT THESE, WILL REQUIRE AN ABUNDANCE OF UNSUCCESSFUL EXPERIMENTS. BUT IF, IN A MULTITUDE OF THESE, WE MAKE ONE OR TWO USEFUL ACQUISITIONS, IT REPAYS OUR TROUBLE.
>
> LETTER FROM THOMAS JEFFERSON TO WILLIAM DRAYTON (1786)

There are various models for funding the proposed Jefferson Institute. The authors of the document estimate that a minimum of $20 million/year is required to initiate the program. Funding must come primarily from the USDA, especially in the initiative's early years, but the Institute would be expected to use grants and contracts to leverage other funding from public and private sectors. As specific new crops moved into commercialization, packages of funding and resources could be organized from state and private sources to build on federal investments.

Organizationally, the Jefferson Institute could be set up as a nonprofit research institute with USDA and other funding, or by establishing institute components through cooperative agreements between the USDA and universities. Regardless of the exact model, the authors expect the Jefferson Institute to be affiliated with Land Grant universities and to have close ties to the ARS. If given sufficient flexibility, the institute would be able to cooperate with universities, government agencies, and the private sector in breaking down barriers to new-crops development. The advisory panel with representatives from industry, farm groups, government, nonprofits, consumer groups, and research and extension should be able to guide institute centers in strategic planning for the new-crops development effort.

The authors of this report are convinced that a focused effort led by the Jefferson Institute, working with a multitude of cooperating partners under the banner of the Jefferson Initiative, is the most effective way of capturing the economic and environmental benefits of new crops in an increasingly diversified U.S. agriculture. The *Jefferson Initiative* proposes the kind of substantial, long-term, and coordinated framework necessary for the creation of a successful national strategic program in new-crops development.

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