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Policy Considerations in New Crops Development

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Profitable new crop alternatives have been needed by US farmers for most of the peacetime history of the nation but evidence of comprehensive strategic planning is lacking. Lack of new crop options has been very costly in economic, environmental, social, and political terms and the US trails several countries in strategic planning for new crops development. The long-term, high-risk nature of new crops development is a common barrier to mobilizing private sector interest. Thus, voice, public funding, and leadership, are essential. But competition for resources and the attention of Congress is fierce. A key opportunity and challenge is to develop and present compelling evidence to convince policy makers of their responsibility to legislate for R&D incentives to stimulate new crops development. The European Community (EC) is advanced in doing this. Australia and New Zealand are intermediate in their activities. Global alliances for sharing the risks and the benefits of such developments would advance a strategic approach. United States leadership would strengthen US and world agriculture sustainability.

Economic theory predicts under-investment in agricultural research because it is too easy for "free-riders" to benefit from investments while the investor may not realize acceptable rates of return (Alston et al. 1994). This concept can apply to individuals, companies, states, nations, or groups of nations. The situation is even worse for investment with the higher risks and the longer-term nature of new crops development. Yet, new crops development will be needed even more as widespread adoption of the GATT (General Agreement on Tariffs and Trade) and NAFTA (North American Free Trade Agreement) increases exposure of traditional agricultural crops to free-market forces.

Two key questions are pertinent: (1) is it wise public policy to invest public resources in new crops development? and (2) if the investment is wise, what should be the mechanism for policy development? The objectives of this paper are: (1) to provide reasons why new crops development is needed, (2) to provide evidence that new crops development policy changes are needed, (3) to identify selected barriers to change, and (4) to make policy recommendations to bring about needed changes.

HISTORICAL PERSPECTIVE

More than a century ago, writers were noting the needs and opportunities for profitable new crop alternatives for US farmers. In 1775, George Washington, in a letter, said: "..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 in a degree to other grains, to pulses, and to grasses" (Rasmussen 1975). He then continued with a discussion of his own attempts to grow new crops.

Low prices for US farm commodities became a problem soon after the farming sector had recovered from the Civil War in the 1860s (Taylor and Taylor 1952). During the 1890s, the Peffer Report (US Senate 1894) and the George Report (US Senate 1895), from a subcommittee of the US Senate Committee on Agriculture recommended that cotton growers diversify their cropping system and introduce new crops (Taylor and Taylor 1952). Both reports pointed to the problems of low prices for crops produced in surplus, the lack of markets, and the high costs of production.

Farm commodity surpluses again became a problem in the US after the recovery from the disruption caused by World War I. Some of the most useful history on crop surplus problems is in the 1920s writings concerning causes and consequences (for example, Schmidt and Ross 1925; McMillen 1929). The writers understood and correctly predicted the complexity and long-term nature of the problem of agricultural surpluses and the stress they impose on farmers. Yet there were forces to blunt their message for decades while millions of US farmers went bankrupt.

*Adapted from G.D. Jolliff (1997).

In 1928, Mead and Ostrolenk stated: “If American farmers were generally to adopt the proven methods of scientific agriculture, the farming industry would go quickly and in grand manner into bankruptcy. Farm prices would dwindle to the vanishing point. ... We have here an amazing paradox. Scientific agriculture is the salvation of the individual, but the ruin of the masses” (Mead and Ostrolenk 1928).

In 1929, McMillen warned: “To the end that the increasing farm output shall not have to struggle for the further expansion of already overstuffed American stomachs nor compete in foreign food markets, greatly increased appropriations to develop new non-food uses [including new crops] are needed. The new national wealth eventually created will pay the bill, and probably with the usual 500% annual interest” (McMillen 1929).

In the 1930s, the Secretary of Agriculture, Henry Wallace, apparently had at least some sympathy for the efforts of the National Farm Chemurgic Movement in promoting the production of industrial raw materials from agriculture, as alternatives to surpluses. However, his heart, and USDA funding, was with corn (Hughes 1935; Wallace 1935). History shows that corn was a big winner, but the farmers’ recommendations for new crops development apparently fell on deaf ears, or at least received very limited long-term support.

By 1936, Wallace had observed: “Farm adjustments necessitated by the loss of foreign trade emphasize the importance of developing new uses for crops and crop byproducts. The Department has appointed a committee of scientists from several of its bureaus to study the research now being done in this field and to indicate promising new lines. At present the farmers have profitable uses for only about half of what they grow. The other half they must either throw away or turn to some low-yielding use.”

“…Both hope and fears cluster about the possibilities of chemical research and its bearing upon new uses for the products and byproducts of the farm… Both the hopes and the fears should be discounted. There is no possibility either that chemistry will solve all the farmers difficulties overnight or that it will do away with the need for farms” (Wallace 1936).

In 1937, Dr. Karl Compton, President of the Massachusetts Institute of Technology, addressed the Third Dearborn Conference of the Farm Chemurgy movement. His remarks give some evidence of frustration with the forces which resisted the objectives of the Chemurgic Movement: “To my mind the most significant of all encouraging signs is the phenomenal growth of this farm chemurgic movement which is sweeping the country despite opposition from those who misunderstand it or who believe that their personal interests will be served by its failure. But it will not fail because it is pointed right in the direction of progress; it is based on the new philosophy of creating wealth and opportunity for all rather than the age-old instinct of taking wealth from others; it is essentially cooperative between agriculture, industry and the general public rather than competitive between them” (Compton 1937). Apparently, significant opposition was coming from non-farm and petroleum-producing states (Wright 1996).

A letter from the Secretary of Agriculture reporting a survey made by the USDA, relative to four regional research laboratories, in 1939, stated: “Perhaps the most frequent recommendation made to the Department of Agriculture has been that work should be done in the new laboratories to encourage new or replacement crops which may be developed by agriculture” (US Senate 1939).

Although chemurgists and farmers during the 1930s had been discussing the need for development of new crops, political forces seem to have erected a legislated barrier. Wolff and Jones (1958) reported that the Agricultural Adjustment Act of 1938 did not permit any substantial part of the work of the four USDA regional research laboratories to be directed to new crops development. “According to the original mandate, therefore, practically all USDA utilization research in succeeding years was directed toward finding new, improved, or expanded uses of existing commodities” (Wolff and Jones 1958).

This is one of several cases of internal competition within agriculture for resources, resulting in the lack of resources for new crops development. It begs the question: Is the USDA the most favorable place to locate the leadership for new crops development, because of its vulnerability to political pressure? At the outset, the Farm Chemurgic Council was outside the USDA and financed by the Chemical Foundation, Inc. from funds used for the advancement of science (Benson 1937). “There are no strings on chemurgy, no political affiliations, no loyalties to organizations or obligations of any kind” (Benson 1937). It seemed to flourish until the

funding mechanism became political. Modern-day farm bill debates have revealed the fierce political pressures from vested interests to which USDA can be subjected.

World War II and the Korean War (1942–53) disrupted world agriculture and created enough export demand that there were few problems with the US excess agricultural production capacity. Several federal investments in new crops development during World War II were justified on the basis of strategic raw material needs, such as guayule for rubber, kenaf for fiber, and pyrethrum for insecticide. The ravages of war in Europe were a significant factor in creating demand for US crop production for several years until the European agricultural capacity was restored.

In the meantime, US agricultural crop production capacity had been expanded by technological developments such as mechanization, nitrogen fertilization, chemical weed control, improved crop cultivars and production management, and irrigation projects. Expanded markets developed during the war years provided the outlets to encourage full use of this improved production capacity.

Thus, in the 1950s, an ever larger US agricultural excess production capacity revisited the US farmer with surpluses and low prices, combined with mounting outlays by the federal government. President Eisenhower appointed a Bipartisan Commission on the Increased Industrial Use of Agricultural Products. Some of the Farm Chemurgic Council efforts may have had some influence on the policy-makers asking for this report. A focus was placed within USDA on increased industrial use of agricultural products (Task Group on New and Special Crops 1957).

Recommendations from the Task Group included the discovery, domestication, and commercialization of new crops. Several potential new crops were discovered, including wild plants from within the borders of the US. Unfortunately, only meager funds, if any, were provided for developing cultivars, production practices, and markets for these crops. Research chemists in USDA had major control of this program. Funding of research in crop improvement, production management, and marketing was low to nil. And, nationally, new crops development again was considered secondary to research aimed at finding new uses for existing commodities.

At the same time, policy makers were convinced of the threat of widespread starvation, and the need for the US to be competitive in the global marketplace. As a result, resources were focused on producing the highest possible yields of existing crops. At that time, the soybean was catching on as a new crop after languishing throughout the late 1800s and early 1900s. Investment in soybean had been stimulated by the crisis of a vegetable oil embargo after World War I. Soybean development had advanced enough to begin carrying sufficient political voice to sustain at least a moderate level of federal funding for R&D. But, a strategic plan for new crops development was still missing from US agriculture policy.

Between 1956 and 1958, Wolff and Jones were participants in the renewed, but short-lived, USDA efforts to find industrial crops as alternatives to the post-war surpluses (Wolff and Jones 1958). In 1957, "The Commission strongly recommends that an adequate annual investment in research and development for new crops be favorably considered, along with suitable authority to the administrator of the program to provide incentives where essential to bridge over the awkward stage of establishment" (Task Group on New and Special Crops 1957. Report to the President's Bipartisan Commission). In 1956, the Federal Budget Office appropriated $100 million per year for R&D work on increased industrial use of agricultural products. It might be instructional to know where those funds were used.

There seems to be little evidence that adequate annual investments were made after 1957 to "bridge over the awkward stage" of development for few, if any, new crops. Some wild plants discovered by USDA in that effort have been domesticated and commercialized to some degree by various piece-meal efforts, but most potential new crops still languish in their development because of a lack of strategic planning, a lack of focused responsibility, and a lack of public resources for research, development, and commercialization.

Frustration with commodity policies, which distorted or destroyed incentives to develop new crops, seemed to be expressed in 1958 by the following statement published on the front page of the April issue of the Chemurgic Digest: "As long as the artificial incentives for overproduction keep pouring on surplus, as Assistant Secretary Peterson indicated in his Conference address, research can hardly be expected to overtake the policy errors. Perhaps we should say to inquirers, Write your senators and congressman and demand that the recom-

mendations of the President's Commission be put into action. Then both public and private industrial research would be stimulated." (Note that the 1995 Farm Bill legislation passed as the Federal Agriculture Improvement and Reform Act of 1996, eliminated several crop price support subsidies for the first time in more than 60 years. Based on the preceding quote, some would view such a policy change as a major advance to help level the playing field for new crops development but it may take a few years for the consequences of the change to be observed and understood.) The oil embargo of 1974 drove up world prices for most commodities, including agricultural products. Additionally, agricultural production systems were faltering in some of the world's large, centrally-planned economies. Consequently, markets developed for US agricultural commodities, again prompting the US agricultural production machine to be unleashed, from fence-row to fence-row. This again resulted in severe economic stress for rural Americans as excess production returned with increased force. Federal government programs designed to take US cropland out of production and control supplies were used more than ever before in history. As a consequence of these market gyrations, lack of profitable alternative crops, lack of relevant policies, and bad decisions by farmers, large numbers of farmers went bankrupt in the 1980s. Very low commodity prices in 1998–1999 again caused severe stress.

Recommendations for new crops development were made again to the USDA and to Congress in Task Force Reports in 1984 (CAST 1984) and in 1987 (Sampson et al. 1987). Congress responded by creating an institutional innovation in the 1990 Farm Bill. It was the Alternative Agricultural Research and Commercialization (AARC) Center (now Corporation) AARC Center mentioned below.

The negligible amount of funding for new crops research within the AARC Center underscores the need for a national commitment to new crops-specific development, with direct funding sources within budgets or within organizations. This would short-circuit the redirection of resources away from new crops to new uses of existing crops as has been accomplished so easily, and so consistently in the past. The creation of at least one separate, narrowly targeted program, is necessary.

NEW CROPS POLICY

There is evidence that it is wise United States public policy to invest public resources in new crops development (Janick et al. 1996; Jolliff 1996). Benefits of past new crops development need to be estimated and documented in the literature, to counter the political barriers to the advancement of new crops development. For example, soybean developed as a new crop in the US from 1920 to 1970 has contributed to: (1) farm-gate wealth generation for the US, (2) rural prosperity, (3) improved US balance of trade, (4) multiplier effects in the US economy (including the advancing of meat animal industries—domestic and foreign, (5) decades of reduced government commodity program payments by providing an alternative crop to surplus crops such as maize, (6) bio-control of pests through interruptions in the maize monoculture, (7) modeling a transition to more environmentally friendly and renewable resource use, (8) the increase in no-till practices to reduce soil erosion. In 1996, soybean was no longer considered a new crop. Public-funded strategic policy is needed for developing new-crops that are economically productive, socially equitable, and ecologically benign (Kloppenburg 1988).

New crops introduced from foreign lands form the foundation of agriculture in the US (Janick et al. 1996) and Australia (Wood et al. 1994a). In fact, very few US or Australian crops have been domesticated from indigenous species.

For more than a century, US farmers have had insufficient numbers of profitable new crops as alternatives to surpluses. The needs for, benefits of, and calls for, new crops development have been well documented (US Senate 1894, 1895, 1939, 1957; Holmes 1924; Schmidt and Ross 1925; National Industrial Conference Board 1926; Mead and Ostrolenk 1928; McMillan 1929; Taylor and Taylor 1952; Task Group on New and Special Crops 1957; Wolff and Jones 1958; Sampson et al. 1987; Jolliff and Snapp 1988; Jolliff 1989; Rexen 1992; Wright 1993, 1995, 1996; Jolliff 1994, 1996; Janick et al. 1996).

However, the US has few, if any, examples of comprehensive tactical operations in new crops development as a result of any non-crisis-based strategic plan. Why is this? Is it that new crops have no voice to compete for resources? Have the command-and-control politics of US agriculture been simply too powerful (Browne 1990)? Are the past benefits of new crops not recognized? Are the costs of not having new crop

options not recognized? Do agriculturists at all levels, including scientists, have insufficient understanding of new crops and their development to be advocates of public resource allocation to this topic?

In the 1990 Farm Bill, the US Congress approved the creation of the Alternative Agricultural Research and Commercialization Center (AARC) within the USDA. The Center was established in 1992. There have been many budget battles for funding the Center, partly because of differing views of what the Center should do. During the first three years of operation, most of the Center's resources were devoted to joint-venture commercialization projects related to new uses of existing agricultural commodities. Funded projects reflected personal, corporate, academic, or political affiliations of several of the AARC Board members. Projects involving corn, wheat, cotton, alfalfa, and peanuts received the majority of the resources. Only a few new crops (e.g. kenaf, lesquerella, and milkweed) received funding, and only one project was a research grant.

This is typical of US agricultural politics of the past 200 years. Congressional fights during the debates on the 1995 Farm Bill (which was passed in 1996) confirm that US agricultural policy is heavily influenced by powerful special interests (O'Connell 1994; Kilman 1995). Historically, US agricultural policy has lacked a strategic plan to develop profitable new crop options for US farmers and the national good. There have been several abortive attempts to develop new crops, but these have been crisis-based and piecemeal. They lacked the organizational structure, support, and commitment within a Congressional mandated strategic plan. The USDA needs to rely on strategic planning to attain its goals (O'Connell 1994) because of the swing in political power away from production agriculture. This could be a good sign for new crops development.

Europe

The EC leads the world in strategic planning for new crops development. The First Framework Programme (1984–88) introduced medium-term planning of agricultural research on a European-wide level for the first time. Research on industrial crops and non-food production was the focus because of the costly surpluses of products like sugar, cereals, and animal products and deficits of cellulosic fibers and proteins. Consumer preferences also were changing towards more "natural" and "environmentally-friendly" products (Rexen l992). A breakthrough was achieved with the Second Framework Programme which ran from 1988 to 1993 (Rexen 1992). The Third Framework Programme (1990–94) overlapped with the Second Framework Programme by two years, and further developed the strategic multidisciplinary, trans-national approach, involving both public and private sectors.

These Framework Programmes included 429 Agriculture, Agro-Industry and Fisheries proposals involving 3,332 participants with a total research budget of 780 MECU (Rexen 1992; Mangan et al. l995).* Non-food components were expanded in the Fourth Framework Programme, launched at the end of 1994. Mangan et al. (1995) reported on 133 of the projects from 18 countries.

New crops activities in Europe are mainly focused on industrial crops for non-food use or renewable resources (Capelle 1996). The crops activities are placed into three categories: (1) existing crops for new markets; (2) new crops for existing markets; and (3) new crops for new markets. "The third category is the most fundamental, strategic, and is highly risky. Therefore, governments and EC authorities see a clear function for themselves in stimulating activities within this category. Agricultural income, overproduction, rural policy, and environment all play a role in this government support. In the UK, France, and Germany the main topic is alternative energy (biomass, bioethanol, biodiesel), while in other countries, especially the Netherlands, a niche approach is preferred," with an emphasis on vegetable oils (*Crambe abyssinica, Calendula officinalis, Limnanthes alba*), specialty fibers (*Cannabis sativa*), and secondary metabolites (*Carum carvi*).

The UK is participating in the EC Framework Programmes. The Alternative Crops Unit was set up within the UK Ministry of Agriculture, Fisheries & Food (MAFF) to act as a catalyst to carry forward the Government's initiative (and strategy) on developing new crops for industry and energy (MAFF 1995). In recent decades, food production had been the overriding priority for the UK agricultural industry. Now there is widespread interest in new crops for industrial feedstocks, energy, manufacturing, rural development, and use of land no longer needed for food production (MAFF 1995). This effort apparently was launched in July 1994 with the release of a document entitled "Alternative Crops, New Markets" and was advanced by the

*One ECU has been referenced as equivalent to approximately 1.20 to 1.33 US dollars (Capelle 1996).

Technology Foresight Programme which emphasized wealth creation and the enhancement of quality of life, by making recommendations for development.

Australia

Australia has an institutional innovation which aids new crop development efforts; the Rural Industries Research and Development Corporation (RIRDC) is jointly funded from public and private sources (Wood and Fletcher 1994). A five-year new crops project jointly funded by this Corporation and the Grains Research and Development Corporation was initiated in July 1993, providing resources for several activities, including support for the First Australian New Crops Conference. This project followed a previous investment in market based methodology to choose new crops for development (Russell et al. 1992) and is supplemented by several small projects on a range of species. In these projects there must be commercial investment to qualify for RIRDC support. Even though five years is a short term for new crops work, the concept is a good start, and one of the more innovative approaches. Time will tell how much political control of programs is exercised by entities tied primarily to traditional crops.

The two-volume report by Wood et al. (1994a,b), also funded and published by RIRDC, is perhaps the most thoughtful, comprehensive, and well-written treatment of new crops development experiences available. They analyzed the development of about twenty species, some of which have become well established crops in Australia and, at the other end of the spectrum, some which have not realized their expected potential. These volumes illustrate the kind of publication which is needed to develop a strategic plan and to design operational tactics. There is little or no economic incentive for private industry to be the sole source of funds for this kind of work.

DEFINING THE PROBLEM

Agriculture is complex and new crops development is not a panacea. But new crops development has a place, and the merits and potential of new crops have shown their worth in the US through the development of crops such as maize, wheat, and soybean. The problem is the over-concentration of efforts and resources on a few major crops during the past century or more. At the same time, there has been under-investment in the development of economically viable alternative crop choices for farmers in sustainable farming systems.

There are positive consequences from increased crop diversity. Profitable new crop options expand the opportunities for farmers to use their ingenuity in developing new cropping systems which can also improve soil and water quality (National Research Council 1993). The social and environmental benefits from new crops development need to be quantified and publicized. “It is a challenge to link the social and economic factors that determine producer behavior with the physical, chemical, and biological factors that determine the effects of that behavior on soil and water quality” (Batie 1993).

Many calls, reports, and recommendations have been made for the development of profitable alternatives to surplus crops (Janick et al. 1996). The literature strongly supports the notion that new crops development could provide opportunities for enhanced agricultural sustainability (US Senate 1894, 1895, 1939, 1957; Holmes 1924; Schmidt and Ross 1925; National Industrial Conference Board 1926; Mead and Ostrolenk 1928; McMillan 1929; Taylor and Taylor 1952; Task Group on New and Special Crops 1957; Wolff and Jones 1958; Sampson et al. 1987; Jolliff and Snapp 1988; Jolliff 1989; Busch et al. 1994; Jolliff 1994; Wright 1995, 1996; Jolliff 1996; Busch 1997). Yet there continues to be serious under-investment in this area.

It is a high-risk, long-term activity and benefits are diffused across producer, processor, and consumer sectors, often without regard to who made the initial investments (Alston et al. 1994; Janick et al. 1996). Alston et al. (1994) explained the economics of public-sector agricultural R&D, and the basis for government intervention in agricultural R&D. New crops research is a prime example of the necessity of public funding to establish and sustain a core national program to identify and develop profit potentials in new crops. This in turn could attract private participation and risk-taking which is necessary for market forces to function as the development of a new crop advances through the commercialization process.

However, new crops development, by definition, has no established support constituency to secure the needed public funding. Therefore, this important area of research and development receives minuscule public

investment compared to the need and the opportunity for national return on that investment (Jolliff and Snapp 1988; Jolliff 1989, 1994, 1996).

The Need for More New Crop Options

Farmers lack adequate profitable new crop alternatives to make their cropland productive in a sustainable manner. This is evidenced by data on government-financed idled cropland (i.e. acreage set-aside, or cropland reduction), costly government subsidy programs, and farmer displacement from the land (Jolliff 1996). Data for idled cropland are available from the USDA, since 1933. Approximately 30 to 60 million acres, or 10% to 20% of US cropland, has been taken out of production each year during the majority of the peacetime years since 1933. Had there been profitable new crops available (while meeting newly developed market demands), this land could have been producing new wealth each year. That wealth could have been multiplying throughout the nation indefinitely, as it was invested in various enterprises. Instead, taxpayer funds have been used to take the wealth-generating resource out of production. Opportunities exist to partner internationally to share the costs, risks, and benefits of new crops development. This should be done in the same manner as the international agricultural research centers.

Financial Consequences

Since 1933, the federal government has employed at least six different programs to take cropland out of production to control surplus crop production (Crosswhite and Sandretto 1991). Large financial, social, environmental, and political costs have accrued to the nation as a consequence of idled cropland. Jolliff (1996) estimated the costs and lost opportunities for 1978 through 1994 of certain components of agricultural crop commodity surplus-related programs to be $932 billion, in 1995 dollars. These programs were created (and costs/lost opportunities incurred) substantially because of insufficient profitable new crop alternatives for farmers to remain economically viable, and operate at sustainable risk levels.

The financial cost estimate included: (1) government outlays for farm income stabilization; (2) certificate programs which were used in place of cash; (3) annually-compounded interest on the outlays and certificates (because the government continues to pay interest on borrowed money spent for these programs); (4) lost revenue opportunities on idled land that was available to produce new crops (had they been developed); and (5) the lost multiplier effect (for economic activity) on the lost revenue opportunities. No financial cost estimates were made related to the surpluses during the eras of 1956 to 1973, 1933 to 1942, or earlier eras such as 1919 to 1935, or 1870 to 1914. Further, no estimates were made of the social, environmental, or political costs of farm policy in promoting surplus crop production for any period of US history.

Loss of Farmers

The consequences of the lack of adequate profitable new crop alternatives for farmers has been serious for farmers themselves. Since 1933, more than 4 million US farms (>70%) have been lost as economic units (National Research Council l995), resulting in approximately 20 million people being displaced from farms. Many farmers have had little or no profitable choice but to produce crops which are commonly in surplus, and part of government programs, and to use the available tools to try to remain economically viable. The improved tools, such as cultivars, technologies, and inputs associated with those government program crops are increasingly controlled by large agribusinesses. This further limits the choices available to farmers (Smith 1992a,b, 1993).

“Some farm groups are concerned that some of the technological innovations that will be necessary to develop new agricultural products, such as genetic engineering, will be made and patented by large agribusinesses. Such a development could contribute to the growing trend of economic concentration in agriculture, these critics contend, and could mean a shift in economic power from individual farmers to private industry, whose interests may not represent what is best for American agriculture” (Congressional Research Service 1988).

Availability of an array of profitable new crop options could mobilize farmer ingenuity at the local level. However, farmers are not well organized outside of their association with specific commodity-based entities.

Therefore, avenues for farmer voice in Washington, DC are generally tied to existing enterprises and industries and innovative areas such as new crops lack representation and action.

Environmental Consequences

The lack of profitable crop and management options during the past sixty years has forced many farmers to accelerate industrialization and specialization in fewer crops in accord with government programs. The results often have been unfriendly to the environment because of increased soil erosion and water quality deterioration. Consequences of government crop production programs are seen, for example, in the changing level of annual average nitrate concentration in ground water (National Research Council 1993). The effects of government programs have been described in a National Research Council Report as follows: "Incentives are perverse. Price support, deficiency payment, and supply control policies should be reformed to remove barriers to voluntary adoption of improved farming systems. The structure of US farm programs induces a bias toward intensive farming practices to boost yields and to expand the base acreage of the cropland that can be enrolled in the price support program" (National Research Council 1993).

Social Consequences

Farm policies have promoted an extractive type of agriculture, producing undifferentiated bulk commodities which are substantially under government control and regulation. Large supplies of low-cost bulk commodities can mean economic prosperity for the many trade industries dealing with marketing, and those providing production inputs. But, increasing portions of that business by-passes rural communities. A small, and declining, share of the retail food dollar is going to the farmer (Smith 1992a,b, 1993). Smith (1992b) reported that "In real terms from 1910 to 1990, the value of the marketing sector grew from $34.5 billion to $216.8 billion, the input sector from $12.6 billion to $57.9 billion, while the farm sector shrank from $24.2 billion to $22.6 billion. The absolute values of the market sector and input sector increased 627% and 460%, respectively, while the value of the farm sector declined over the same period." Thus, rural America is participating in less of the nation's economic activity associated with the agricultural industry (Smith 1992b). Off-farm corporate industries may flourish, even as farmers go bankrupt, rural communities disappear, and rural poverty spreads.

Political Consequences

Government-subsidized export of surplus US crop commodities on the world market, sometimes at prices below the costs of production, place serious negative economic pressure on the agricultural sectors in some developing countries. Development of more crop options would allow free-market forces to operate more widely.

ESTABLISHMENT OF FARM POLICY AND RESEARCH FOR NEW CROPS DEVELOPMENT

General Policy-making Forces and Tendencies in National Politics

Just and Huffman (1992) described how research funding in the land grant system has oriented public research toward private good when it should be more oriented toward public good. The history of new crops research and development bears out the difficulty of retaining focus on the public good.

"The loss of public support has tended to exacerbate political-economic problems of the land-grant system by (1) increasing emphasis on serving the [narrow] clientele that provides political support, (2) increasing efforts by interest groups and administrators to control and prioritize research agendas, and (3) increasing privatization of land-grant activities" (Just and Huffman 1992).

Federal farm policy development has been substantially driven by short-term profits and crisis-based factors. Such forces run counter to the long-term strategic planning needed to give priority to new crops development. Zulauf and Tweeten (1993) see the need to re-order the mission of agricultural research at land-grant universities by providing a new vision for using farm products for non-food and non-feed uses. But, it is likely that Congress would need well-documented, strong justification to take needed action in the absence of strong lobbying forces. It may be necessary for Congress to fund the development of those justifications

because there is a lack of resources for such activity. An alternative is to wait until the next crisis of agricultural surpluses, low prices, and farm bankruptcies, and hope that enough "corporate" memory is developing to amass the political pressure needed to pass legislation for sufficient funding. At the end of 1999 it appears that "the next" crisis of agricultural surpluses and low prices arrived in 1998, and continues in 1999. There appears to be little evidence of the amassing of corporate memory to develop needed political influence to fund the Thomas Jefferson Institute for Crop Diversification that Congress authorized in June 1998.

Just and Rausser (1993) argued for the necessity of strategies to alter the landscape of special versus public interests in agriculture. They believe the current trend for scientists within land grant universities to seek private funding, produce privately appropriable products for organized interest groups, and to produce private goods and patents that compete with private sector products will undermine the very foundation of the land grant institutions' existence. Alternatively, they recommended an "active role of organizing political support for public good research activities, and of restructuring incentives to enhance the public-good productivity of research and outreach." They suggest institution building that lowers transaction costs of public interest group formation. These principles apply to the needs for new crops development.

Mtika et al. (1994) studied the perceptions that external interest groups have influence on land-grant university agricultural and natural resource research agenda-setting. Their concern was that the sustainability of the American agricultural system is being threatened by some of the very practices that have contributed to its success. They found that the priority concern of commodity and agricultural industry support groups is to maximize production and profits, while consumer and environmental organizations place priority on consumer and environmental welfare. They cited long-standing calls to redirect land grant university emphasis in agriculture and natural resources research. The call has been to shift from production-oriented agricultural research to that which emphasizes a broad food systems approach which includes linkages between agricultural production, community viability, food safety and security, public health, and environmental protection. The paper recommended that land grant universities focus on reconciling interests of established constituents and potential constituents by developing partnerships in the funding, design, implementation, and evaluation of research. This new paradigm could be tested in developing a national, and global, new crops initiative at a level needed by society to improve agricultural sustainability. This would provide a win-win situation even as the larger agricultural industrial complex sees the opportunities for no-win situations to develop; united voices could encourage Congress to pass needed legislation for new crops development.

Agrarian Myths and Agricultural Policy

Agrarian myths have had a major influence on US farm policy. Browne et al. (1992) demonstrated how specific social and economic interests have used agrarian myths to gain legitimacy in the eyes of the general public. Since World War II, the notion that the world will soon be starving gained a foothold, on the basis of fear founded in experiences from the Great Depression and World War II. Higher yields of the major US field crops was touted as the answer to these frightening problems. This led to the development of the production ideology.

For many years this ideology espoused maximizing production, while little attention was given to the consequences (economic, social, environmental, and political) of such a strategy. Technology was viewed as the answer to all ills. This ideology has been around for the past half century and has become deeply-held dogma. Several elements of the agricultural community placed great trust and focus on yield increases of major field crops as the answer to the needs of rural America and to the alleviation of starvation in developing nations. Curricula in agricultural universities followed suit, eroding attention to topics which explore the potential of, and the prospects for, new crops development and related issues.

The Paradox of Success

The production ideology has led to the paradox of success, in which the consequences of technologies to promote high crop yield served to undermine public support for productivity research (Weaver 1993). Agricultural research has provided technological advances that have dramatically increased agricultural production. However, major economic, social, and environmental consequences have been externalized. Society has reacted. Subsequently, a paradox of success has emerged (Weaver 1993). The result has been waning societal

support for an agricultural research system which had successfully generated solutions to quantitative productivity problems for specific sectors of agriculture. Little attention was given to the economic, social, and environmental consequences of the science and technology which led to crop yield increases. Improved understanding, within the agricultural industrial sectors, of these concerns may improve the prospects for broad-based support of longer-term investments in federally-funded research.

Society is forcing a paradigm shift in agricultural research through the reduced funding for research in production agriculture. Because of budget cuts, scientist staffing is being reduced in the land grant university research system—dramatically in some instances. The disciplinary infrastructure critical to a sustainable science and technology base for crop production is in jeopardy for some disciplines at some universities, e.g., funding sources are forcing major shifts of soil scientist efforts from agriculture to environmental soil science at some universities. A need exists for broad-based expertise to address new crops development. A national focus on new crops development would serve as a worthy place to apply and revitalize that disciplinary expertise while producing valuable new annually renewable wealth.

The history of agriculture has not been emphasized in the land grant university curricula in recent decades, so past mistakes may be repeated. Recent generations of graduates in agriculture have been focused sharply on technology and the desire for well-paying jobs. Students were given relatively little, if any, exposure to the factors, thought processes, belief systems, and social interaction skills which are critical for effectively working where agricultural science and technology interface with society. Congress could provide funds to remedy this situation. A well-funded Thomas Jefferson Institute for Crop Diversification (Janick et al. 1996), including an educational objective with World Wide Web resources, would be one good way to start.

Farmer Creativity Compromised

Farmers are among the most innovative workers in the United States. However, when it comes to long-term plant breeding, agronomy, chemistry of utilization, and marketing of new crops, the task is beyond the realm of the farm. Farmers need profitable new crops as the tools to use in developing innovative and sustainable farming systems. Therefore, the national long-term agricultural research agenda is critical to supporting sustainable agriculture. The production ideology, crop subsidies, and current research, focused on a few major crops, have, by default, formed the basis of neutralizing or destroying significant amount of the creative capacity of many farmers who could contribute to the development of profitable new crop alternatives—and, in new farming systems. For several decades, public research funding provided farmer technologies to produce greater excesses when, in reality, they also required profitable new crop alternatives.

Farmers can do much to facilitate the development of profitable new crop alternatives. To do so, they need mechanisms through which to collaborate. They need freedom from the seriously distorting effects which government programs for farm income stabilization and research programs have had on the investment of resources in crops research, development, and marketing. Profitable new crops are tools which many farmers would learn how to use wisely, if they had a chance. Farmers have done this in the US in the past.

Recognition of Reality

Only in recent years has it become widely recognized that frequently, world hunger is the result of economic, social, religious, and political problems, rather than the result of global incapacity to produce food. Hunger in Somalia was a recent compelling illustration of this point, which convinced more of the general public that simple production of more food in the US will not necessarily reduce the number of starving people in the world. It is increasingly recognized that the dumping of US grain on world markets at prices which have been below the costs of production can have serious negative effects on the food production systems of developing countries. Thus, there are far-reaching justifications for the US to increase development efforts for profitable new crop alternatives for farmers globally to facilitate strong agricultural and food production systems world-wide.

Special Interests of Off-farm Agricultural Trade Industries

Numerous off-farm trade groups stand to gain by promoting the production ideology. This leads to the funding of research projects of direct benefit to them in the short run, in preference to the funding of new

crops development. Industrial trade suppliers of farm inputs, and buyers of farm outputs can benefit from increased acreages of government program crops. Unfortunately, the low crop prices force farmers into bankruptcy, even though, after changing hands, the land would most likely remain in production (Smith 1992a,b). The costly negative consequences of the production ideology have usually been externalized; that is, the costs are borne by people who are different from those who reap the rewards of the practices (National Research Council 1993). Most of these external costs are not included in the economic assessments of the "fruit" of research investments in the production ideology. However, calls for accountability in agriculture-related industries are increasing (National Research Council 1993; Jolliff 1994).

Browne et al. (1992) have supported the argument that US agricultural policies contribute little to the public well-being. The burden of proof for making agricultural policy changes needs to be shifted from those who wish to change it, to the agricultural interests who defend the status-quo (Browne et al. 1992). Martin (1996) has suggested that there is a need for more comprehensive analysis of the distributional impacts of agricultural research and new technologies; who wins, who loses?

Reichelderfer (1991) discussed how "economic input has often been linked with the perceived, pure objectivity of its dollars-and-cents conclusion...yet even the most objective economic scientist must make subjective judgments in order to conduct an analysis...thus any number of held beliefs, including one's view or definition of "sustainability," can influence the outcome of an analysis of the agriculture and sustainability issue."

Cultures of the Land Grant University and the Federal Agricultural Research Systems

Land grant universities have been a primary source of graduates employed as research scientists and agricultural policy-makers within its own ranks, and within the USDA and other government agencies. Thus, there has been a tendency for certain mind-sets and paradigms to be perpetuated. Some of these paradigms may be so difficult to change that new institutional innovations will be necessary (Meyer 1993, 1995). In such an environment, the forces of organizational inertia may prevail. Systematic distortion of information can take place for the preservation of the organization (Bella 1987, 1996, 1997). Change may be impossible. It is important to consider how the strengths of the existing organizations might be used for new crops development while avoiding those characteristics which may hinder progress.

A national focus on new crops development would need to center its research with the scientific expertise of the land grant university system. Collaboration with scientists within the USDA and other federal agencies would be vital for an effective and efficient program. That type of collaboration was conducted in the 1930s when the Farm Chemurgic Council, which was funded by The Chemical Foundation, led new crop development efforts and promoted USDA and land grant university/agricultural experiment station involvement (Barnard 1937).

Danbom (1991) suggested that the tension in the American agricultural research system has become a crisis of purpose and direction. If that is true, then national leadership, long-term funding, and institutional structure for new crops development becomes all the more important. Otherwise, it may be very difficult for public scientists to dedicate themselves to the complex, and poorly-funded, problem-solving aspects of new crops development. It may be necessary, for example, for non-profit organizations to be associated with selected land-grant universities to facilitate the wise use of federal, and possibly state, funding to get efforts focused in new directions which do not have strong political voices, but which are in the public interest.

The land grant university system, which includes the state agricultural experiment stations and the cooperative extension service, is one of the most successful social experiments in history (Meyer 1995; Campbell 1995). However, the US agricultural research system is under stress, as evidenced by the waning public support for traditional productivity goals (Meyer 1995; Campbell 1995; Weaver 1993). There is increasing public pressure for the focus of research to shift away from purely sectoral goals, such as quantitative productivity, which are usually associated with corporate agriculture, to more broadly-defined societal goals of maximum social welfare, or the greatest good for the most people (Weaver 1993). Such a change of focus in the land grant university research system would represent a quantum leap for some scientists in departments such as crop science and agronomy. With appropriate funding, such changes are feasible.

New crops development is consistent with society's desires to shift research focus to emphasize the diversity of farming systems approaches which include linkages with environmental, social, food safety and security, and public health concerns. However, environmentalists are not in favor of developing new crops with the prospect of simply shifting a traditional extractive type of agricultural system to different plant species. Given the opportunity for funding support, a shift of research focus would provide an opportunity to enlist substantial scientific expertise to advance new crops development. As stated earlier, resources allocated in past efforts to initiate new crops development research regularly have been diverted to new-uses research on existing commodities. Therefore, to get the job done, it is essential that Congress design an innovative institutional structure and provide financial resources (Janick et al. 1996) to mobilize sufficient expertise in problem-oriented research teams, and coordinate efforts to realize successes within much shorter time frames than experienced in the past. Such successes would satisfy and encourage Congress, the public, the scientists, farmers, and the agriculture trade industries so that investment in the national effort could grow, and gain widespread commitment as a long-term investment strategy.

Scientist Culture

Many scientists within agriculture at land grant universities are second and third generation students of the land grant system. That professional environment in recent decades was dominated by the production ideology which led to the "paradox of success."

As a result of the integration of the myths of agriculture and the production ideology, a culture has developed within the community of land grant university agricultural research scientists (Castle 1993; Meyer 1993, 1995). It has been fueled and guided by research granting systems (Huffman and Just 1994) and professional reward structures which promote individual faculty achievement in selected, narrow discipline-focused topic areas. Some of the resulting incremental advances in crop yield served sectoral needs of vested interest groups that play major roles in gaining research funding. Professional scientific societies catered to those trends, but are now seeing the need to help institutional change by taking risks, promoting lifelong learning, advancing diversity, and finding balance, for example, through a common vision (CAST 1996).

Research scientists have had little choice but to work on investigations for which funding was made available by the powers-that-be within the system. There are problems in the funding systems. For example, the competitive grants in the federal peer-review system have been found to have conflicts of interest that subvert the process and make it political (Huffman and Just 1994). Yet numerous scientists with vested interests in the competitive grant system exude an attitude of elitism with that system once they have established their financial foothold. Competitive grants have been a major source of research support in selected areas which commonly serve special interest groups who lobby directly and indirectly to set the research agenda for use of federal and state funds. The competitive grant system is subject to political pressure at all levels.

Just and Huffman (1992) have discussed several facets of the fundamental challenge facing the land-grant system, which are applicable to the topic of new crops development. "The fundamental challenge of the land-grant system is how to achieve effective disciplinary integration, and appropriate balance among basic, pretechnology, and applied research and resident teaching activities while effectively utilizing the individual creativity and broad base of intelligence in the scientific community to respond to emerging public needs in both the short and long run" (Just and Huffman 1992).

Need to Democratize Agricultural Research Agenda-Setting

Busch (1984) argued that democratization of the research formation process, through the broadening of the range of interests that have access to it, would go a long way toward ensuring that the research agenda was not controlled by special interests. For example, if the general public knew the true costs of not having developed profitable new crop options for farmers, new crops development would probably gain significant support in a democratized system of research funding. Scientists, especially those in the public sector, have a responsibility to aid in developing remedies for an apparently faltering system, even if the remedy requires involvement in national policy development.

The Challenge to Change

The process of change in the scientist culture is difficult. "The major problem facing the Land Grant Colleges of Agriculture is that they are part of an intractable, even unruly organization called a university, encumbered with unique characteristics or principles that should not be compromised" (Meyer 1995). Meyer (1993) suggested that the land grant colleges needed help in escaping from old ideas, which meant escaping from old organizations built on the past. "Changing the mindset of personnel throughout the organization is the most difficult task of all, but most essential if renewal is to occur" (Meyer 1995). National agriculture policy, through priority setting and research funding, with a clear priority for new crops development would provide one more incentive for change within the land grant system. Adequate funding in new priority areas would effect such a change quickly.

The Peer-Review System

Peer-reviewing has been used to develop credibility in scientific publications, research agenda-setting and research resource allocation. It has served society well in the past, and may continue to do so in the future. However, there is concern about the system. In the broader university community, Goodstein (1995) sees the peer review system in academia threatened. As referees, scientists perform a professional service and are not required to justify what they write in reviews. Thus, they can "with relative impunity...delay or deny funding or publication of their rivals. When misconduct of this kind happens, it is the referee who is guilty, but it is the editors and program officers who are responsible for propagating the system that make misconduct almost inevitable…purely intellectual competition has now become an intense competition for scarce resources."

Competition for scarce resources has long been a challenge at all levels of funding when working with new crops development. The competition occurs with established crops, between new crops, and among investigators on a single new crop. Significant competition occurs on Capitol Hill where resources are allocated.

The result of this scientist culture has been discipline-oriented or scientist-oriented research which provides results that bring rewards to the scientist, but often do not provide a good solution to the problem because of unanswered questions (Hatfield 1991). A contrasting organizational research structure is one in which the problem, and the development of the research questions to solve the problem, drive the process.

New crops development ought to be an example of a problem-oriented research structure which addresses the needs of society. Problem-oriented research provides for a better understanding of the knowledge gaps and necessary solutions (Hatfield 1991). Teaching problem-based issues requires enough funding to put teams to work. Funding of new crops development has seldom, if ever, had that kind of approach in the US.

Seitz (1991) discussed evidence for dissatisfaction with higher education reward structures, a need for universities to develop clearer statements of mission which are more relevant to social problems, and a need to tighten the linkage of mission and faculty rewards. Again, a focused institutional innovation on new crops development would give a clear mission to which many scientists could contribute, and would have clear social relevance and environmental and economic benefits.

RECOMMENDATIONS FOR NATIONAL AGRICULTURE POLICY CHANGE

Education

Selling policy ideas based on rational judgment requires education. Education about new crops development can serve as motivation, but the topic has not been included in core secondary or higher education. Scientists seldom write about new crops development policy. Little is written about the history of the issue. Incentives to do so are meager, if existent. There is a large education gap, and consequently most present-day leaders need the benefit of exposure to this information. If a new crop is sufficiently profitable, it will be grown. In fact, it may be difficult to prevent it from being grown, as is the case with illicit drug crops. Therefore, profit development is the key to successful commercialization. Profit development requires research investment; and, this has been evident historically with most industries.

Policy-makers respond to their clientele, who would also benefit from information on the benefits of new crops development. The public is readily receptive to the concept of new crops development.

Unfortunately, agricultural policy decisions are controlled by special interest groups who have particular programs to protect. Such groups often have short time scales for problem solving, compared with that required for strategic planning with new crops. So, these special interest groups are important targets for information. They need to be shown the benefits likely to accrue from new crops development.

Three types of information are especially pertinent: (1) benefits of past new crops development, (2) costs and lost opportunities from the lack of sufficient new crops development to meet farmers' needs, (3) evidence of the sufficiency of genetic materials, technologies, expertise, and financial resources to develop profitable new crops, (4) progress with new crops development efforts in various countries of the world (e.g. the EC), and (5) the positive economic, environmental, social, and political impact possible from new crops development.

Credible and convincing data need to be prepared and venues identified for educating those persons who otherwise view new crops development as a threat to their interests.

Incentive Barriers

New crops development involves a complex production system. The diversity of genetic materials, soils, climates, pests, crop husbandry, and human cultures (e.g. economic, education, research, agrarian, industrial, political, religious, military) throughout the world provides every imaginable kind of incentive and counter-incentive for new crops development.

For example, for-profit organizations "live and die" by the economic gains of their endeavors. Therefore, such organizations should not be expected to invest in the early stages of new crops research and development (R&D) which are very long-term and high-risk. When profit potential is discernible, there should be policies to remove barriers preventing private industry involvement. On the other hand, such private organizations, including established crop commodity organizations, should be made aware of the merit of providing political support for public investment in new crops R&D.

Research scientists at public land grant universities in the US over the past 40 years have been rewarded by a system based heavily on publishing in refereed scientific journals. So long as scholarly work was conducted, little scrutiny was placed on the economic, environmental or social relevance of the scientific investigations conducted. Very few resources have been available to university research scientists to conduct investigations on new crops, when compared with the scale and stability of funding available for the established crops. Thus, to the credit of the researchers, new crops research work often was accomplished as the result of curiosity and scholarly inquiry even if funding was scarce. But, that situation has not led to the commercial developments needed by farmers.

There has also been little incentive for a scientist to risk investing time in advancing strategic planning for new crops development, for the good of society. For the past 30 years, there has been an increasing focus in the academic reward system on the acquisition of extramural research grants. Scientists have become entrepreneurs, brokers of science and influence, and business operatives, in order to sustain the economic base of academic research. This has seriously chilled relationships for free information exchange.

Scientists' energies and investigations have been increasingly dictated by the sources of funding. Therefore, the control of the funding sources is substantially the control of the research agenda for public scientists. And, public research funding is highly directed by vested interests through the political process. Thus, long-term high-risk research on new crops receives little support. This topic is discussed further below.

In a similar manner, public scientists working for the United States Department of Agriculture (USDA) invest their time in response to the funding and political pressures applied. Very little incentive, and significant disincentives exist for working on new crops development.

Therefore, policy considerations for new crops development should address the incentive system currently in place.

Making New Crops Development a National Priority.

New crops development needs to be a national priority to attract resources in adequate amounts with sufficient stability to meet strategic plans. Such an approach has been adopted in some countries, as discussed above.

New crops development has no voice or organized industry. Therefore, a substitute force is needed for Congress to use as a basis for action. A comprehensive documentation of the past, present, and future benefits of new crops development could be a powerful force for Congress to use as justification for new innovative legislation. Articulation of the national justification for developing profitable new crop alternatives for farmers should become a focused priority as one aspect of national agriculture policy development.

Public resources should be invested to acquire independent and objective assessments by rural sociologists, crop scientists, agronomists, horticulturists, historians, economists, economic botanists, ethicists, and others to provide the necessary data to accurately characterize and justify needed investment in solving this long-standing national need. In economic terms, the financial, environmental, social and possibly political costs of not having developed sufficient profitable new crop options for US farmers during the past century need to be calculated and added to benefit estimates. Congress would be well served by supporting comprehensive studies of this nature to justify public investments on a long-term basis for new crops development for US farmers. These kinds of studies could also evaluate the institutional innovation needs and opportunities for accomplishing the new crops development task.

Using New Crops-specific Legislative Language

Specific language is required to distinguish new crops development from work on new uses of existing commodities, and to guard against resource redirection or diversion from new crops, as has happened repeatedly in the US. Work on new uses of existing crops has a well-established voice which can speak for itself and should be distinguished from new crops R&D.

National agriculture policy language should be specific for new crops development. This type of support is necessary to bring new crops to a profitability level which will then attract private sector participation in joint ventures for commercialization as now promoted by the AARC Center. Crop domestication, development, and commercialization time frames of 40 to 80 years need to be shortened to 20 to 30 years, via improved funding, to better serve the needs of US farmers and to simultaneously be serving the national good.

Minimum funding of $100 million per year is proposed. This level of funding was appropriated by The US Budget Bureau in 1956 to launch an effort to increase industrial use of agricultural products (Task Group on New and Special Crops 1957). Unfortunately, a political barrier had been written into the Agricultural Adjustment Act of 1938 and did not “permit any substantial part of the work of the four USDA regional research laboratories be directed to new crops development” (Wolff and Jones 1958). Current US agricultural policy should be purged of any similar types of language which may be counterproductive for the good of farmers, rural America, and the nation.

Creating an Institutional Innovation

Such an innovation would require an organizational structure, and voice, targeting specific objectives and known barriers to new crops development. This has been recommended many times in the US, and attempted more than once. As explained above, new crops development has faltered without a Congress-sanctioned and mandated new crops-specific voice (US Senate 1939; Wolff and Jones 1958; I. Wolff pers. commun. 1984; Janick et al. 1996).

Unfortunately, there has not been adequate attention paid to the four policy considerations, above. The outcome has been piece-meal, short-lived programs that have yielded very little commercial product. Several countries of the EC and Australia have some institutional innovations which are likely to be more successful with strategic planning and implementation programs.

New crops development should be kept distinct in mandate from programs designed to develop new uses for existing commodities commonly produced in surplus. This is because farmers still lack sufficient profitable new crop alternatives, which they have needed for more than a century. The remedy is Congressional action.

SUMMATION

United States farmers have needed profitable new crop alternatives to grow in place of surplus crops throughout the entire peacetime history of the nation. Despite many efforts during the past century to encour-

age change (Janick et al. 1996), agriculture policy initiatives have been inadequate to meet the needs. Why is this?

New crops development is long-term, high-risk, and the benefits often accrue to persons other than those making the initial investments. Thus, it lacks attraction for private investment. Since new crops development benefits the nation in general, public resources are appropriate for support. However, public resources commonly are allocated to areas where there are special interests with forceful representation—and new crops development is not one of those areas.

Therefore, it is necessary to create an environment in which Congress has the incentive to press for the funding of such work. The political climate of the mid 1990s suggested that budget deficits and the national debt provided an important mechanism for connecting with the consciousness of Congress and the American public.

More than four million US farmers (>70% of the total number), plus their families, have been displaced from the land since 1935 (National Research Council 1995). This is substantially because of insufficient economic opportunities, i.e., the lack of sufficiently profitable alternatives to the few major crops commonly produced in surplus. Public resources have been concentrated in traditional crops, and have not been invested in new crops development. Resultant distortions in research investment and markets have been large, widespread, and costly. Economic costs and lost opportunities from not having developed profitable new crop options for farmers has been estimated to total as much as $932 billion, in 1995 dollars, for the brief period between 1978 and 1994 (Jolliff 1996). This problem has been in place for more than a century.

Barriers to policy development include the nature of the policy development process, agrarian myths, special interests which compete with public interests for resources, and organizational cultures in the public-funded research communities.

Society is insisting that the agricultural research system become more responsive to the broader needs of society as contrasted with the narrower, more traditional focus on the ideology of production agriculture. One of the most easily quantified evidences of pressure for change is the reduction in public support for the public agricultural production research system.

Therefore, in the public interest, it is recommended that the United States Congress:

1. Make new crops development a national priority to improve US farmers" sustainability and to enhance rural development.
2. Use legislative language that is new crops-development-specific to: (a) distinguish its intent from work on new uses of existing commodities, (b) to assure intended results, and (c) to guard against resource redirection or diversion—as has happened repeatedly in the past.
3. Create, or modify, an organizational entity to ensure the focused capability, responsibility, and accountability to: (a) respond to the unique needs, opportunities, and challenges of new crops development, and (b) compete with powerful established interest groups for public resources.

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