Chapter 1
Summary

Interest in diversifying agriculture has been increasing, due to changes affecting the industry. Widely fluctuating farm incomes ($38 billion in 1979,$13 billion in 1983, and $34 billion in 1986)[1] have led the agricultural community to seek new, high-growth markets. Erosion of the economic base of rural communities, and the pressures faced by small farms, have intensified the search for new economic activities. Soil erosion, agrichemical groundwater contamination, and other environmental problems resulting from modern agriculture have spurred interest in developing new crops that may be better suited to some geoclimatic regions than current crops and that provide fanners with more crop rotation alternatives. Policymakers dealing with government budget constraints are seeking ways to reduce surpluses and commodity support payments. Concerns about the long-term supply of petroleum have led to an interest in the potential of renewable resources, including agricultural commodities, to replace petroleum derived products. Development of new industrial crops and uses of traditional crops is viewed as at least a partial solution to these pressing problems.

Agricultural commodities traditionally are used for food or livestock feed, but potentially could provide chemicals for use in a wide range of industrial applications. Vegetable oils and plant resins can be used as components of lubricants, paints, detergents, and plastics among others. Starch can be used to produce biopolymers, or as a food source for bacteria that produce commodity chemicals. New fibers can replace wood pulp in a variety of paper and paperboard products. Crops that are traditionally grown in the United States are used in limited quantities for industrial purposes. Additionally, the United States imports selected agricultural products for industrial use. Uses of traditional crops can be expanded, and new crops can be adapted to U.S. production to provide many of these products.

Many constraints must be overcome before agricultural commodities will become a primary source of industrial raw materials. Technical constraints include agronomic problems such as seed shattering and dormancy, low yields, insect pollination, and photoperiodism among others. For some new crops, the lack of germplasm may constrain research efforts. Utilization research is needed before chemicals from crops can be used industrially. And, the efficiency and productivity of new industrial use processes must be increased. With sufficient research funding and effort, it is likely that many of these technical constraints can be overcome.

Economic, rather than technical constraints, will likely impede the development of new industrial crops and uses most severely. New industrial uses must be acceptable to manufacturers and the products produced accepted by consumers. For example, several proposed new crops produce chemicals that are already being used in industrial processes. The current sources of these chemicals are petroleum and agricultural imports. To be acceptable to manufacturers, chemicals derived from new crops must be competitive with current sources in terms of price, quality, and performance. Similarly, many potential new uses for agricultural commodities will compete with products already in use.

New crops must also be acceptable to farmers. Adoption of new crops by farmers will depend largely on their profitability relative to crops the farmer can grow now. Profitability can be increased if multiple uses for new crops can be found and developed; many of the chemicals that could be derived from new crops currently have limited demand.

Research to develop industrial uses of agricultural commodities is diverse and takes place in government laboratories, universities, and the private sector. Several Federal programs exist that can facilitate the development of new industrial crops and uses, and funding for research and development activities has been an estimated $10 to $15 million annually. Federal funding has primarily supported research on the new crops guayule, kenaf, *Crambe*, and rapeseed, and on new uses of cornstarch (e.g., for ethanol production). Federal funding sources in-

[1]These numbers represent net income from farming in 1982-84 dollars. Net income includes cash receipts from farm marketing and government payments, plus non-money and other farm income minus production expenses. Off-farm income is not included. Source: USDA Agricultural Statistics, 1988.

elude primarily the Department of Defense, the National Science Foundation, the Department of Energy, and the Department of Agriculture. Proponents of developing agricultural commodities as industrial raw materials perceive these programs as being inadequate, and have called for new initiatives. Legislation introduced in the 100th and 101st Congresses, and passed in the 101st Congress, authorizes funding for research, development, and commercialization of new crops and new uses of traditional crops. Goals of the legislation include diversifying and stabilizing the agricultural sector, enhancing rural development, and increasing family-farm incomes. Additionally, proponents hope that the new crops and uses of traditional crops will be more environmentally benign than current crops, will improve the U.S. balance of trade, and will decrease Federal agricultural payments. However, several questions remain concerning the appropriate goals of new crop and use development, and the best institutional arrangements for achieving those goals.

Major Findings

As with all new technologies, development, commercialization and adoption of new industrial crops and uses of traditional crops will have many impacts, some positive and some negative. At issue are questions such as:

- What benefits can realistically be achieved?
- What adverse impacts can be expected?
- What constraints (policy, institutional, social, economic, environmental, or technical) impede development?
- How can policy and institutions be structured to be efficient, cost-effective, maximize benefits, and minimize adverse impacts?

Chemicals derived from agricultural commodities have a potentially broad range of industrial applications, and many are technically promising. Technical feasibility, however, will not be sufficient for widespread adoption. Chemicals derived from agricultural commodities must be less expensive than those currently available, or provide a superior product in terms of quality, performance, supply availability, or environmental benefits among other criteria. Environmental regulations could have a significant impact on the development of new industrial crops and uses of traditional crops. And economic competitiveness will hinge on the ability to develop markets for processing byproducts. OTA concludes that:

- Development of new industrial crops and uses of traditional crops offers future flexibility to respond to changing political, economic, and environmental conditions in supplying industrial materials, although currently, many are not economically competitive with alternatives.
- Commercialization potential will be enhanced if research and development efforts take a systemic approach and are directed toward creating a package of products rather than a single product.

It takes many years to develop a new use or crop, and during that time political, economic, and environmental conditions could change. Research and development of new products and processes lays the groundwork necessary to respond quickly and effectively to these changing conditions. It is unlikely that individual firms will be willing to make large investments to develop substitutes for future hypothetical changes. Arguments can be made, however, that this may constitute a legitimate public-sector investment.

The economic competitiveness of using agricultural commodities for industrial uses hinges on the ability to develop markets for the primary product and any processing byproducts. For example, the cost of using corn for ethanol production depends on the cost of the corn minus any credits received for the gluten meal, distillers grains, and oil produced as byproducts. The industrial market share of vegetable oil fatty acids will depend on the fatty acids being competitive with petroleum-derived products as well as the extent to which the glycerin byproduct can compete with petroleum-derived glycerin, and markets can be found for the meal. Thus, development strategies must consider developing a package of products, rather than a single use only.

Research Needs

At the present time, the information that is needed to make a thorough assessment of the market potential, and socioeconomic and environmental impacts of developing new technologies using agricultural commodities is seriously lacking. A clear need exists for research not only to help develop new crops and uses, but also to help policymakers evaluate the potential benefits to be gained from these new technologies. Rigorous

analysis of the potential magnitude of impacts, who gains and loses and by how much, and whether benefits can be achieved in a cost-effective manner is needed. In particular:

- Chemical, physical, and biological research is needed to improve the efficiency of obtaining chemicals from agricultural crops, to improve the efficiency of their use in industrial processes, to develop new products, and to improve the agronomic characteristics of agricultural crops.
- Market research is needed to identify commercial opportunities and constraints.
- Social science research is needed to evaluate the socioeconomic impacts that will result from technical change.
- Environmental research is needed to evaluate the potential positive and negative environmental impacts of developing new industrial crops and uses of traditional crops.
- Germplasm collection and germplasm storage and maintenance research is needed.

Many technical and agronomic improvements are still needed before new industrial crops and uses of traditional crops will be commercially viable. Lack of germplasm may constrain research efforts, particularly for new crops. Research to improve technical feasibility can improve the economic competitiveness of using chemicals derived from agricultural commodities, but it cannot be assumed, that in all cases, these improvements will be sufficient to guarantee success. Market needs must be identified and products developed that can economically meet those needs. Developing a product first, and then trying to find a market, is not the most effective approach. Identifying market needs will require an understanding of the short and long term trends in input supply, product demand, and structural change occuring within the industries involved. Development of new industrial crops and uses of traditional crops, like any new technology, will benefit some, and harm others. These trade-offs have not been analyzed adequately.

Potential Impacts of Using Agricultural Commodities as Industrial Raw Materials

Due to the lack of studies needed to evaluate the potential market and impacts of new industrial crops and uses of traditional crops, definitive statements concerning the potential benefits and cost-effectiveness of development cannot be made at the present time. Of the few available studies, most examine expanding ethanol production from corn, an industrial use of a traditional crop. While they do not directly analyze new industrial crops or uses of traditional crops, some studies are available that examine issues pertinent to the development of these new technologies. For example, research evaluating factors that cause instability in the agricultural sector and new technology adoption by farmers have been conducted, and can be used to analyze the potential impact on small farms and agricultural stability of new crops and uses. Additionally, studies on rural industrialization and changes in rural employment during the 1970s, when demand for agricultural commodities grew rapidly, can provide insights on potential rural employment impacts of expanding industrial uses of some agricultural commodities. These studies raise serious questions about the potential benefits and costs of new industrial crop and use development. Based on these studies, OTA concludes:

- Evaluation of rural employment in the 1970s and 1980s suggests that the rural employment impacts of new industrial crops and uses may be modest, and that most employment increases are likely to be in metropolitan rather than rural communities. The rural counties likely to be most affected are the fewer than 25 percent that are agriculturally dependent.
- Development of new industrial crops and uses of traditional crops, without additional policy measures, is likely to have a modest impact on the income of small-commercial and part-time farmers.
- New industrial crops and uses of traditional crops could potentially provide a domestic source of strategic and essential chemical compounds that are currently imported or derived from petroleum, however, many are not currently economically competitive with these sources.
- New industrial crops and uses of traditional crops can potentially have positive and negative environmental impacts.
- It is not clear that the development of new industrial crops and uses of traditional crops will significantly rectify factors that cause instability in agriculture, and thus stabilize the agricultural sector.

- It cannot be unambiguously stated that new industrial crops and uses of traditional crops will improve the U.S. trade deficit or significantly reduce Federal expenditures.
- Development of new industrial crops and uses of traditional crops could potentially compete for some of the markets of currently produced crops.
- Development of new industrial crops and uses of traditional crops has the potential to provide diversification alternatives and new agricultural markets.
- Premature attempts to commercialize the new industrial crops and uses of traditional crops may delay any further efforts to develop these uses.

Rural development, small farm survival, and agricultural stabilization will require comprehensive approaches. Development and commercialization of new industrial crops and uses of traditional crops can be one component of these approaches but, by itself, will not be sufficient to accomplish these goals. Information needed to assess the cost-effectiveness of new crop and use commercialization relative to other strategies is not available. Historically, however, social rates of return to agricultural research investment have been high.

Rural Employment

The structure of rural communities has changed significantly over the last 40 years; rural economies have diversified and are now strongly linked to the U.S. national economy and to global events. Linkages between agriculture and rural economies has eroded over this time, and rural development policy and agricultural policy are no longer synonymous. Development and commercialization of new industrial crops and uses, while containing industrial elements, is still, however, essentially an agricultural policy.

Proponents of new industrial crop and use development feel that these efforts will increase rural employment through community multiplier effects resulting from enhanced farm income and increased agricultural input use, and by creating new jobs resulting from the full-utilization, expansion, or construction of processing and manufacturing facilities that use agricultural commodities. The second half of the 1970s was characterized by rapid expansion of agricultural production and provides insights on potential employment impacts of increased industrial demand for agricultural commodities. Over this period, rural employment in agriculturally related industries increased slowly. In general, the agriculture processing industry is not labor-intensive, has excess capacity, and has increased productivity even as employment levels dropped. Agriculturally dependent counties (less than 25 percent of all rural counties) are those that will be most significantly affected.

Agricultural commodity processing facilities are not always located near the site of production of the commodity. Indeed, at least half of all jobs in agriculturally related industries are located in metropolitan, rather than rural, areas. Need and availability of skilled workers, institutions that provide managerial and vocational education, natural resources, and appropriate infrastructure including transportation and information technologies will be major determinants of manufacturing or processing plant location. These needs will generally favor metropolitan areas, rather than rural communities. However, special storage, processing, or transportation requirements may make construction or expansion of processing facilities in crop production regions desirable.

Aid to Small Farms

One goal of using agricultural commodities as industrial raw materials is to provide higher income alternatives to small farms. However, in many cases, the problems faced by small farms are not the lack of available technologies, rather it is the inability of their operators to take advantage of new technologies. Small farm operators may lack financial resources or the management skills needed. Adoption of new technologies is risky, and operators of small farms may not be willing or able to accept the added risk. Gains from new technologies accrue primarily to early adopters; it is unlikely that small farms will be the earliest adopters of many of the new technologies.

Small, part-time farmers receive the majority of their income from off-farm activities; changes in the market prices of commodities may not significantly increase their total income. For those that participate, agricultural commodity programs buffer the impacts of price changes for many traditional crops. These factors limit the income effects for small farms that might result from the development of new uses for traditional crops. Commercialization of new industrial crops and uses of traditional crops—

combined with programs to teach operators of small farms new management skills, help them obtain financing, and provide insurance for the additional risks assumed-may help to enhance small farm incomes. Without these additional programs, commercialization of new industrial crops and uses of traditional crops may not significantly enhance the income of small farms.

Strategic Materials and Petroleum Replacement Potential

Several of the new crops could provide the United States with a domestic supply of materials that have strategic and essential industrial uses. The United States currently imports agricultural commodities or uses petroleum derived chemicals for these purposes. Materials of strategic importance are stored in a strategic material reserve. Domestic production may be desirable for security reasons.

Agricultural commodities used to produce fuel and primary feedstock chemicals have the potential to replace the largest quantities of petroleum imports. Other markets, such as some of the uses for vegetable oils, are much smaller. It is technically feasible to use agriculturally derived chemicals as fuel and industrial feedstocks, but because the petroleum industry is a highly integrated and flexible system that can change the type, amount, and price of chemicals it produces to respond to market conditions, the use of agriculturally derived chemicals is not currently economically competitive in most of these markets.

Large-scale development of agricultural commodities for fuel and chemical uses will likely result in major changes in land-use patterns, accompanied by environmental impacts, as well as impacts on food prices. Additionally, petroleum-derived energy is used to produce agricultural commodities and convert chemicals derived from these commodities; this usage must be subtracted to determine petroleum replacement potential.

Environmental Impacts

New industrial crops and uses can potentially have positive and negative environmental impacts. New crops offer additional options for crop rotation, soil erosion control, and other conservation efforts. However, farm commodity programs that discourage crop rotations, and conservation programs that prohibit harvesting of crops grown on some land may inhibit the use of these new crops. Changes in the 1990 Farm Bill may correct some of these constraints. Several new crops are better adapted to semiarid environments and require less irrigation than many crops currently grown in those areas. Potential positive environmental impacts could result from new uses of traditional crops such as road de-icers, and coal desulfurization. Alternative fuels could potentially improve air quality. Currently, these uses are not economically competitive, in part because the prices of alternatives do not reflect the true cost of adverse environmental impacts.

Many new crops are not native to the United States and the introduction of foreign species can sometimes lead to unexpected problems. Some newly introduced crops (i.e., Johnson grass) have become serious weeds, while others could potentially serve as a repository for crop diseases. Many crops may be genetically engineered, and the environmental release of these crops raises many environmental questions. Additionally, large changes in land use patterns and inputs could have far-reaching environmental impacts, not all of which may be positive.

Agricultural Stability

Instability in the U.S. agricultural industry results primarily from weather variation, market imperfections (i.e., lack of complete markets and asymetric information between buyers and sellers) and macroeconomic policy (primarily U.S. Government deficits and money supply policies). Globalization of the goods and financial markets magnifies these impacts.

The development of new industrial crops and uses of traditional crops does not address macroeconomic policies. In addition to the agricultural sector itself, many industries that will use new crops to produce new products are also highly sensitive to macroeconomic conditions. Diversifying into these new markets will not shelter the agriculture sector from macroeconomic impacts. Diversification of crop production can moderate adverse weather impacts, but if monoculture increases to meet the demands for new uses of traditional crops, the opposite effect could occur. Development of new marketing institutions, or greater use of available market instruments that reduce risks (i.e., futures markets, forward contracts, crop insurance, etc.) could improve agricultural stability. Improvements in market institutions and reduction of U.S. deficits are needed to help stabilize agriculture.

Diversification

Technological approaches can offer new market and production opportunities and provide flexibility to respond to changing economic, political, and environmental conditions. Many of the new industrial crops and uses of traditional crops are not economically and/or technically competitive in their current state of development and under current economic conditions, but conditions can change. It takes many years of sustained research to develop a new crop or a new use. Providing research and development funding and encouraging public sector/private sector interaction now, can greatly reduce the lead time necessary should conditions change and commercialization becomes attractive.

Premature Commercialization

Premature commercialization attempts could potentially halt, or at least delay, the development of a new industrial crop or use. As an example, public disillusionment with degradable plastics has resulted in lawsuits against companies making degradable plastic products, and some demands for the elimination of publicly supported research for these products. Legislation passed in the 101st Congress authorizes funding to encourage rapid commercialization of industrial uses of agricultural commodities.

Additional Potential Impacts

Current domestic uses for many of the chemicals derived from new crops are limited, and production of these crops to meet this demand may not have a huge impact on U.S. agriculture in the aggregate. Concentrated production in a localized region could possibly be significant for that area. Simultaneous development of several new crops and uses will have larger impacts. Development of new uses for a currently grown crop that raises the price of the crop may have a more significant impact due to the volumes involved and the impact on commodity support payments. The potential for domestic and export market expansion can only be discussed in crude terms. Good market studies are needed, but unfortunately are lacking.

Impacts of most new crops and uses on Federal farm expenditures, surpluses, and the trade deficit cannot be determined at the present time. Improved information about market demand and profitability is needed to make those assessments. Surpluses and commodity payment impacts of new crops will depend on which currently grown crops are replaced by new crops. For example, corn is a surplus crop and, in 1988, nearly 60 percent of the crop was enrolled in the commodity support program. On the other hand, production of oats in the United States is in deficit and, in 1988, less than 1 percent of the crop was enrolled in commodity programs. Shifting acreage from corn production to new crop production may result in decreased corn surpluses and reduced Federal commodity expenditures. However, shifting acreage from the production of oats to new crops will not significantly affect surpluses and commodity payments.

For new uses of traditional crops, impacts on Federal expenditures will depend in part on whether the new use must be subsidized to be economically competitive. Ethanol is an example. Excise tax exemptions potentially could offset most, or all, commodity program savings. The impacts of new industrial crops and uses of traditional crops on the trade deficit are similarly ambiguous.

Development and adoption of new crops or new uses could result in some income reallocation. Many new crops and uses have high protein meal as a byproduct. Significant levels of adoption could potentially displace soybean meal in some livestock feed markets, and lower soybean prices. Byproducts from ethanol production will also put pressure on soybean prices as they compete in the same oil and livestock feed markets. Soybean farmers in the Southeast and Delta regions are most likely to be adversely affected, while corn farmers in the Midwest will be most positively affected.

Many new crops have the potential to substitute for, and at least partially replace, major agricultural exports of developing countries, some of which are of strategic importance to the United States. Substitutes for coconut oil, palm oil, and rubber are examples. Attempts to increase exports of corn gluten meal, which is a byproduct of ethanol production, may meet with resistance from the European Community. An improved understanding of potential international ramifications is needed.

Policy Issues

The lack of research to evaluate market potential and impact of new industrial crop and use development, as well as the technical constraints that still exist suggest several research needs as have already been discussed. What can be clearly deduced, however, is that commercialization prospects will be

improved if a systems approach is taken, and if a package of technologies and products is developed with markets identified for all products.

Because legislation has the goal of developing new products, research will need to be more focused and directed than would be the case if the goal were to improve scientific knowledge. To improve the science base, it is reasonable to focus research funding on proposals that are the most scientifically sound and interesting regardless of the topic area. However, taking this approach to the development of new products is likely to exclude research needed for commercialization. Research results are unpredictable, so some undirected research is still needed. However, most of the research should be focused on overcoming as many obstacles to commercialization as possible.

While disciplinary research in the physical, biological, and social sciences is needed, multidisciplinary research will be essential. Because of the diffuse geographical nature of agricultural production and industry distribution, multiregional research may be needed in some cases. A European Economic Community research program (ECLAIR —European Collaborative Linkage of Agriculture and Industry Through Research), established to develop industrial uses of agricultural commodities, recognizes these needs and explicitly requires multidisciplinary research and the active participation of at least two countries in all projects. U.S. legislation does not require multidisciplinary or multiregional research although this type of research could qualify for funding. Ample evidence exists, however, that if it is not required, it is unlikely to occur.

There must be a mechanism to set research priorities. Development of many new crops and uses will be expensive. As an example, between 1978 and 1989, Federal expenditures for guayule development have been nearly $50 million. Estimated funding requirements through 1996 are an additional $38 million. Funding is limited, and it must be decided how to best allocate those resources. A mechanism is needed to assess the benefits, negative impacts, timeframe and development costs of new technologies, and then to allocate resources to those that are most promising.

To achieve technical change, policies must address constraints and opportunities in the research and development, commercialization, and adoption stages. A wide variety of options and flexibility in their selection will be of paramount importance. Funding for research, public sector/private sector cooperative agreements, and commercialization is important, but not the only issue. Finding ways to help industry minimize the search costs of acquiring information, providing technical assistance and training to aid the adoption of new technologies, and agricultural extension programs to aid farmer adoption of new crops also are important.

Additional questions exist as to the most appropriate institutional structure for administering policies and developing new technologies using agricultural commodities: is the establishment of a new institution (within but independent of USDA) necessary, or might a reassessment of how USDA sets priorities and allocates resources for research and development of agricultural technologies achieve similar ends? An underlying force driving the call for new legislation to help develop new industrial crops and uses of traditional crops is the perceived lack of responsiveness of the U.S. Department of Agriculture. Proponents of new industrial crop and use commercialization feel that USDA provides inadequate research funding and insufficient interaction with the private sector. Similar frustrations are often voiced with respect to other agricultural technologies. In terms of research, development, and commercialization, new industrial crops and uses of traditional crops are no different from other agricultural technologies. Thus a critical issue is whether it is best to establish corporations to commercialize each technology type, or to address fundamental problems that exist within USDA.

On the one hand, a new institution could focus its full attention on new crops and uses and serve as a central organization that is easily recognized and accessible to those interested in commercializing new agricultural technologies. On the other hand, a new institution may be isolated and unable to coordinate with other agencies in USDA, develop its own constituency (making it difficult to terminate) and may develop goals that are in conflict with those of the USDA. Historically, the establishment of new institutions within USDA has been a serious problem, and has hampered attempts to coordinate policies and programs. Addressing fundamental problems with USDA priority setting and research resource allocation mechanisms will improve the research and development prospects of a wide range of agricultural technologies, not just new industrial crops and uses of traditional crops.

Policy Options

Technical change (i.e., changes in an economy's mix of products and processes) involves three stages: research and development (development of ideas or models), commercialization (commercial development and marketing), and technology adoption.[2] To successfully achieve technical change, policies are needed that help overcome constraints in all three phases. Presently, science policy focuses mainly on research, development, and commercialization. Issues of adoption have been given little attention. OTA has identified several potential policy options to help facilitate the development of new industrial crops and uses of traditional crops.

Research and Development

Public-sector research for industrial new crops and uses requires a sustained allocation of personnel and funding. Emphasis should be placed on interdisciplinary research. Interregional projects will be needed in some cases. Research needed to develop new industrial products must include marketing, economic, and social welfare analysis as well as biological and chemical research. Potential environmental impacts must be evaluated; this is particularly pertinent for genetically engineered crops, and for new crop introductions that involve expanding the range of indigenous species, or the planned introduction of non-indigenous species to the United States. Research to develop new industrial crops and uses could be constrained by the lack of appropriate germplasm needed to improve agronomic characteristics and to screen for useful, and as yet unidentified, chemicals. Collection and research to improve maintenance and storage of germplasm is needed.

Technology Transfer and Commercialization

The Technology Transfer Act of 1986 and the National Competitiveness Technology Transfer Act of 1989 removed most major barriers to private-sector cooperative agreements with Federal laboratories. There is still a need to provide adequate funding for these activities and to provide professional incentives for public sector participation. In addition to cooperative agreements, public sector/private sector interaction can be stimulated by other means as well. Other policies might include loans and use of specialized public-sector facilities and equipment. Programs such as the Small Business Innovation Research Program can help the private and public sectors share the cost of risky research.

Federally supported research is conducted in thousands of Federal, university, and non-profit laboratories. Learning about and assessing pertinent information is still a major problem for private firms interested in utilizing publicly funded research. Holding conferences that showcase Federal laboratory research and improving databases describing federally funded research are two methods of providing information to private fins.

Adoption

Many new products and technologies developed and marketed may be inputs or processes needed to produce other products. In these cases, the adoption of these new technologies by firms within an industry will be needed. As with technology transfer, gathering information about new technologies is costly. Many firms maybe small or lack an in-house research capacity, and may need assistance before using these new technologies. There may be a need for technical extension programs. Likewise, agricultural extension as well as commodity programs will play major roles in determiningg the extent and speed of farm adoption of new crops.

Legislation Passed

OTA has identified the need for policies to address the research and development of new industrial crops and uses of traditional crops, technology transfer and commercialization issues, and the issues of the adoption of new technologies. These options are discussed in chapter 6, and were made available to the House and Senate Agricultural Committees during their debate on the Farm Bill. In the fall of 1990, the 101st Congress passed the Food, Agriculture, Conservation, and Trade Act of 1990 (1990 Farm Bill). The issues of industrial crops and uses of traditional crops, USDA research priorities, and agricultural commodity programs that affect farmer adoption of new crops were debated and legislation passed as part of the Farm Bill. Following is a summary of the main legislation that affects the development and commercialization of new industrial crops and uses of traditional crops.

[2]For the purposes of this report, commercialization is being defined as the actual production and sale of products. The process leading to that stage is referred to as research and development.

- The Alternative Agricultural Research and Commercialization Act was passed to establish a Center for these actitivities. Establishment of Regional Centers to assist commercialization was also authorized.
- Commodity programs were changed to allow for greater planting flexibility. A Triple Base Option was adopted.
- An Agricultural Science and Technology Review Board was created within USDA to review current and emerging agricultural research issues and to provide a technical assessment of new technologies.

Alternative Agricultural Research and Commercialization Act

This Act creates an Alternative Agricultural Research and Commercialization Center, an independent entity located within USDA. The Act also authorizes the establishment of two to six regional centers to assist in commercializing new industrial crops and uses of traditional crops. Heavy emphasis is placed on commercialization funding. Funding is also provided for research and development, and public sector/private sector cooperative research agreements.

Because of incompatible timing of the Farm Bill and Appropriations legislation, funding for the new Alternative Agricultural Research and Commercialization Center was not provided. Instead, the Critical Agricultural Materials Act was reauthorized through FY 1995 and funding appropriated for the Office of Critical Materials. Congress will likely consider funding of the Center in 1991.

Commodity Programs

Congress passed a Triple Base Option plan, to begin in 1992. Under the plan, the base acreage for program crops (wheat, corn, grain sorghum, oats, barley, upland cotton, or rice) is established. Acreage Reduction Programs (ARP) will remove a percentage of that acreage from production. Fifteen percent of base acreage is excluded from receiving commodity payments and can be planted to program crops or other designated crops (i.e., oilseeds and industrial or experimental crops designated by the Secretary of Agriculture). An additional 10 percent of acreage can be planted to non-program crops without the loss of program base acreage. These new flexibility provisions, and removal of acreage that is eligible for support payments will help to remove some of the disincentives to the planting of new industrial crops. Additionally, target prices were nominally frozen at 1990 levels, but changes in the way deficiency payments are calculated may effectively reduce price levels.

Agricultural Science and Technology Review Board

This board consists of 11 representatives from ARS, CSRS, Extension Service, Land Grant Universities, private foundations, and firms involved in agricultural research, technology transfer, or education. The purpose of the Board is to provide a technology assessment of current and emerging public and private agricultural research and technology transfer initiatives and to determine their potential to foster a variety of environmental, social, economic, and scientific goals. The report of the Board is to include an assessment of research activities conducted, and recommendations on how such research could best be directed to achieve desired goals. Establishment of this Board is an attempt to address some of the fundamental problems existing in the USDA research and extension system.

The legislation enacted addresses some research, development, technology transfer, and farm adoption issues relevant to new crops and new uses of industrial crops. Congress may wish, in the future, to explore further other issues that could enhance the development of these crops and uses. These issues include germplasm collection and maintenance, the role of technical assistance and technical extension programs, improving equity markets in rural communities, and establishing programs to help small farm operators adopt and utilize new technologies.

Conclusions

Using agricultural commodities as industrial raw materials will not provide a quick and painless fix for the problems of agriculture and rural economies. They can provide future flexibility to respond to changing needs and economic environments, but many technical, economic, and policy constraints must be overcome. Many of the new industrial crops and uses of traditional crops are still in relatively early stages of development. Several years of research and development will be necessary before their commercialization will be feasible. The lack of marketing strategies and research to assess the impacts of new technologies complicates decisions

on research priorities and appropriate policies and institutions needed to achieve success. Potential impacts on income reallocation and the environment, as well as regional effects need further study before large-scale funding for commercialization is required. Successful commercialization will require not just funding assistance, but a systemic policy that articulates clear and achievable goals and provides the instruments needed to reach those goals.

An encompassing research and development strategy is needed and must be designed to meet market needs; hence a strategic, multidisciplinary, multiregional approach should be taken with both public and private sector involvement. Changes in agricultural commodity programs, in addition to those already made, may still be needed to remove disincentives to the adoption of many new crops. Because of research information still needed, and the time still required to develop many of the new crops and products, a two-step approach to commercialization might be useful. The European community is taking this approach by first establishing a precommercialization program to determine feasibility, and then following up with a later program to encourage commercialization. The U.S. Small Business Innovation Research Program also takes a multistage approach to the commercialization of new technologies.

In the United States, initial primary emphasis could be given to the basic, applied and precommercialization research needed to develop new crops and uses. A high priority should be an early technology assessment of products and processes to analyze potential markets, socioeconomic and environmental impacts, technical constraints, and areas of research needed to address these issues fully. The establishment of the USDA Science and Technology Review Board should improve the prospects for this type of assessment. The technology assessment would lay the groundwork for development, and provide the information needed to make intelligent decisions about commercialization priorities, possible impacts of new technologies, and further research or policy actions needed.

Interdisciplinary, and in appropriate cases, multiregional research should be given the highest funding priority. This could include: chemical, physical, and biological research needed to improve production yields and chemical conversion efficiencies, and to establish quality control and performance standards; agronomic research to improve suitability for agricultural production; germplasm collection and maintenance research; and social science and environmental research. Technology transfer issues should also be addressed. These issues include funding for cooperative agreements, database management, and Federal laboratory-industrial conferences.

Once information is available to identify market potential and technical, economic, and institutional constraints, the second step to commercialization can be made. A strategic plan can be developed to commercialize the most promising technologies. Financial aid for commercialization and the role of regulations may need to be considered. Industrial adoption and diffusion of new processes may require additional technical assistance and technical extension programs. For new industrial crops and uses, additional changes may be needed in agricultural commodity programs.

Because many new industrial crops and uses of traditional crops are still in the early stages of development, there is time for a thorough analysis of the actual potential of these new products, the constraints to commercialization, and the potential impacts of development. This information, once it is available, will permit the design of appropriate policy and institutions needed to achieve the benefits that can be gained from using agricultural commodities as industrial raw materials.