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ALTERNATIVE CROPS AND PRODUCTS

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Traditionally, agriculture has been viewed as a source only of food and fiber, although in fact agriculture is already a major supplier of fats and oils for many nonfood products. In the future, while agriculture's traditional mission will remain paramount, it could also become a much more signfificant source of industrial raw materials.

This new facet of agriculture can be based on the cultivation and use of alternative crops that most people have never heard of--guayule, kenaf, meadowfoam, cuphea, and others--and on the increasing development of nonfood products based on soybeans, corn, and many other familiar crops. For the research community, therefore, these new challenges will offer opportunities to expand the horizons of agriculture in the United States.

Why Alternative Crops and Products?

Surplus farm production, while not yet a thing of the past, no longer dominates agricultural policy. Last year's drought and forecasts of global production shortfalls showed that we need to maintain onfarm productive capacity. Future challenges will include the need to integrate alternative crops and increased production of traditional crops into our production system in environmentally and economically sound ways.

New and alternative crops have stimulated a great deal of interest for several very good reasons:

* They can replace imports or can be exported as substitutes for raw materials and finished products.
* They can, in some cases, replace nonrenewable resources, notably petroleum, for energy and chemical raw materials.
* They can help provide needed jobs, often in rural communities. In Illinois and North Carolina, for example, small businesses that manufacture products based on super slurper, a highly absorbent material made from cornstarch,

have helped breathe new life into small town economies. Super slurper, by the way, was developed in the Agricultural Research Service Northern Regional Research Center in Peoria, Illinois.

* They can help build sustainable agriculture by extending the farmer's range of options.
* They can help protect the environment in many ways. For example, encapsulation of pesticides in cornstarch--a new use for an old product--promises to help farmers not only reduce the amount of pesticide used, but also improve the targeting of the pesticide. Another example: If programs such as biomass production for ethanol manufacturing get off the ground, we may find that we are recycling, rather than producing, carbon dioxide, a major cause of global warming.
* And they can have strategic importance by providing domestic sources of raw materials for industrial products otherwise imported or based on imported materials.

A Tradition of Research

These are not new areas for investigation. The Agricultural Research Service conducts research on new crops using biotechnology, chemistry, and bioprocess engineering techniques. The resulting expansion of our knowledge base thus becomes an important resource for solving problems related to development of novel, high-value-added products.

ARS also has a long tradition of "utilization" research aimed at transforming conventional commodities--such as surplus cornstarch, soybean oil, and dairy materials--into novel products that are sought after by manufacturers of plastics, detergents, paint, lubricants, and cosmetics, among others.

Our philosophy is to bring this research to the brink of commercialization and then work with industry. Our responsibilities are enhancing germplasm, improving varieties, developing agronomic practicies, and utilization. Our aim is to help capture markets for U.S. agricultural commodities through greater product diversification.

Support for Research

Never before, however, has the climate been so amenable to progress in this area:

* The Technology Transfer Act of 1986 (Public Law 99-502) requires Federal laboratories to work with industry toward the commercialization of new products. The new cooperative research and development agreements (CRADA's) arising from this law provide the cooperator with a first right to exclusive licenses on patented inventions made under the agreement. Then, ARS scientists work closely with companies to commercialize the technology arising from their research results. ARS has been one of the Federal leaders in this regard, having signed more technology transfer

agreements with industry than all but one other laboratory in the entire Federal Government.

* Several commercialization bills have been introduced in Congress to encourage the development of alternative crops and new products, to foster economic development, and to improve the competitiveness of American farmers and processors. Most of these bills would significantly increase Federal support for the research.
* Secretary Yeutter's continuing support of rural development activities will encourage assistance to entrepreneurs willing to risk developing new products. I might note that nearly half of the cooperative research and development agreements ARS has negotiated to date have been with small rural firms.
* President Bush has clearly taken a stand in support of this kind of initiative, on environmental as well as economic grounds. He is on record, for example, for rebuilding the research effort on ethanol.
* A four-state conference held in the Midwest last March involving agricultural interests in Iowa, Kansas, Nebraska, and Missouri signals strong support for alternative crops and products in the heartland. Another meeting, expanded to include other states, is being planned for next spring here in Washington, D.C.
* And the first meeting of the Association for the Advancement of Industrial Crops, held last October in Peoria, broke new ground in proposing a variety of innovative uses for industrial crops.

Alternative Crops

Alternative crops are plants under agronomic development because they can be processed into products with existing or potential industrial demands. One reason for their importance is the need to reduce our national dependence on imported strategic and essential industrial materials.

USDA has screened thousands of wild plant species to find candidates for industrial materials production. ARS works with the Office of Critical Agricultural Materials of the Cooperative State Research Service to conduct and coordinate research and development of materials for industrial use. Several crop species have been chosen as candidates for commercial development, including kenaf, guayule, winter rapeseed, and crambe.

Kenaf is a fast-growing, fibrous plant that can be substituted for wood pulp in the manufacture of paper. Kenaf compares favorably with wood pulp for newsprint quality and cost. And since imports of newsprint are around $4 billion annually, the potential economic impact is significant.

Encouraged by the American Newspaper Publishers Association, a cooperative agreement has been set up between USDA and industry to promote kenaf as an alternative fiber source for newsprint manufacture. Other uses for kenaf are being explored and appear to have potential. In support of these initiatives, ARS has re-instituted research on agronomic production of kenaf in Texas, Oklahoma, and Mississippi.

Guayule is a native plant of the Southwest that yields natural rubber. The Departments of Defense and Agriculture have an agreement for a joint Guayule Domestic Rubber Project. This project could provide a domestic source of natural rubber to satisfy 20 percent of DOD end-product needs. Research efforts are supplied by ARS and the state universities.

Rapeseed and crambe are members of the mustard family. Both yield erucic acid, which is an important component of specialty lubricants. USDA and various state universities are looking at the practicality of developing an industrial supply of erucic acid using domestically grown winter rapeseed and crambe.

Research efforts are underway on other new crops as well in ARS, university, and industry labs. Meadowfoam produces long-chain fatty acids suitable for cosmetics and lubricants. The Oregon Meadowfoam Growers' Association has promoted extensive plantings, and already a small amount of oil is being marketed to a cosmetics manufacturer.

Cuphea and Lesquerella produce seed oils that are good candidates for domestic production of lauric acid and hydroxy fatty acids, respectively. Imported coconut and palm kernel oils are currently our primary sources of lauric acid for manufacturing soaps, detergents, lubricants, and related products. Imported castor oil is our current source of hydroxy fatty acids, which are used in the production of plasticizers, coatings, lubricants, surfactants, and pharmaceuticals.

The major barrier to expanded production of these crops now may not be scientific but economic. Is the economic return sufficient to attract farmers to production of alternative crops? Can the new crops fit into existing rotations? Will new equipment be needed?

Alternative Products

A different approach is to produce non-food products based on traditional agricultural crops. In this area, ARS focuses on medium-volume products in the intermediate price range, such as specialty chemicals. We have found that agriculturally based products simply can't compete with the high-volume, low-priced products of the American petrochemicals industry. Likewise, we steer clear of the very high priced market end (biomedical products) because this would require only small quantities of major agricultural commodities--and therefore would have an insignificant impact on the agricultural economy.

Using both biological and chemical technology, we are building a resource base of technical know-how. The projects that have been undertaken could open up large new multi-billion-pound markets for cereal starch, soybean oil, and dairy materials (such as lactose and milk protein).

For example, the ARS research center at Peoria has developed technology for incorporating starch from corn or wheat into plastic films. This provides an agricultural mulch film that biodegrades. Other market possibilities include biodegradable trash can liners, grocery bags, and food packaging, as well as injection-molded articles such as beverage bottles. Substitutes for imported gums are being sought by altering starch structure biochemically to imitate gum-like characteristics.

Useful soybean oil products are already being made. For example:

* Printer's ink now requires 300 million pounds of petroleum-based oil every year; a soybean oil substitute could use about 25 million bushels per year of soybeans produced in the United States. Already, soybean-based colored inks that don't rub off are a commercial reality. Research promises to extend this to the much larger black-ink market.
* Biotechnology is being applied to produce hydroxy acids from soybean oil and replace imports of castor oil; current imports of castor oil are in the range of 100 million pounds per year.
* Novel catalysts are being investigated for converting soybean oil to lauric acid, which is used in the manufacture of detergents and lubricants, with the view of reducing or replacing coconut and palm kernel oil imports.
* And soybean oil is being developed as a fuel for farm tractors and to make cosmetics, specialty lubricants, and other higher value products.

Lactose from the dairy industry is being upgraded, through fermentation systems, to health-care products. Experiments in which milk proteins are cross-linked have led to the manufacture of thin, durable, and biodegradable films for packaging.

Impediments to Progress

All of these developments are encouraging, but we shouldn't let ourselves get carried away. If these things could be done easily, they would have been done long ago.

Research has made progress, is making progress, and will continue to make progress. We think the way to continue this progress is to link the research and development components as closely as possible. We might be able to speed up the process with additional support, but it would be unrealistic to expect an overnight turnaround.

In fact, research is out in front of the other factors needed for successful broad-scale industrial uses of agricultural products. For example:

* The economics of developing products from the new industrial crops is almost a Catch-22 situation. Farmers aren't likely to produce a new crop without an assured market, and industry isn't likely to retool for processing an alternative crop without an assured supply. I can point to the Cooperative State Research Service's helping finance construction of a demonstration project for making newsprint out of kenaf pulp as an excellent example of public-private cooperation. Are there other, similar opportunities for leveraging industry's involvement?
* Particularly in the developing stages of new technology, costs tend to be much higher for each unit of production than in more mature technologies. On their own merits, therefore, many new products cannot compete in the marketplace, at least initially. How can start-up costs be minimized?

* Frequently, the total benefit to the overall economy is not figured into the equation. For example, calcium magnesium acetate (CMA) is an effective substitute for road salt, but its cost is considerably higher than that of salt. Yet how much does it save taxpayers in reduced repairs to roads and bridges? How much does it save car owners in reduced rust damage? How much does it benefit water quality and natural ecosystems that new receive salt-laden runoff?

Marketing Strategies

The classical approach to marketing is to look for a need, and then to fill it. Another approach is to develop a new product, and then to look for uses. Obviously, the first approach will be the one taken most often, but there will be room for the second approach at times.

The best-known example of a new technology developed first--and then new uses found--is the laser. More to our point today is another example: Super slurper, which was created in the ARS research center at Peoria and then languished on the shelf for years. This product was originally called "starch polyachrylonitrile graft copolymer," so there is little wonder that people weren't too excited about it. Then, an ARS employee coined the term "super slurper"--a highly descriptive, imaginative name for the product--and industry took a second look. The result has been the development of several innovative, useful products.

There is a great deal of support for continued research and development on alternative crops and products. The potential for commercial exploitation is there. The scientists are ready. Industry is guardedly optimistic. The time is right to move ahead.

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