1998 Annual Conference
New Crops and New Uses: Biodiversity and Sustainability

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Program Abstracts

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WORLD BIODIVERSITY UPDATE

TRENDS IN AGRICULTURAL BIODIVERSITY

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The conservation and sustainable use of agricultural biodiversity (agrobiodiversity) are major concerns of both the Food and Agricultural Organization Global Plan of Action and the Convention on Biological Diversity. This paper explores the concept of agrobiodiversity and identifies trends in the main areas in which research and developments are taking place.

Although the main thrust of agriculture will be continued intensification to meet the world's increasing need for food supplies, accompanied by attempts to reduce pressures to expand the amount of land devoted to agricultural activities, great attention will also be placed on the use of sustainable agro-ecological methods that will reduce the adverse effects of agriculture on biodiversity, to achieve this. Likewise, there will be increasing emphasis on more integrated forms of landscape/bioregional planning that enhance the possibilities of maintaining levels of biodiversity in all forms of land use, including agriculture. The genetic base of crops will be broadened and efforts will be made to increase the small number of species used in mainstream agriculture through the promotion of under utilized crops and the introduction of new ones. Special attention will be focused on the genetic conservation of wild relatives of medicinal, aromatic, and ornamentals plants.

Attention will be focused on the fact that despite the industrialization of much of agriculture, most farmers in the developing world are small-scale, often peasants. These producers still use traditional subsistence farming methods growing a wide range of species with many harvested from the wild. Lessons will be learned from these systems and at the same time, efforts will be made to enhance their productivity. The vital role of traditional farming knowledge developed by indigenous communities in evolving production methods adapted to local conditions and in organizing grass roots methods of genetic resource conservation will be recognized, as will issues such as property rights, land tenure, and equitable sharing of benefits.

Most conservation biologists do not show much interest in agroecosystems or in the biodiversity they contain, mainly because they are already modified by human action. Similarly, there has been a lack of interest from agroecologists in the biodiversity found in traditional agroecosystems because it is not obviously connected to production. It is argued that these attitudes must change. Biodiversity is essential for agricultural production, as agriculture should be for biodiversity conservation.

New alliances will be developed between the official sector and non-governmental organizations to carry out these objectives.

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STRATEGIC OPPORTUNITIES IN NEW CROPS AND NEW USES

POLICY CHALLENGES IN NEW CROP DEVELOPMENT

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New crop development has clearly suffered from a lack of political and policy support. Several reasons are present for this. The most obvious is the lack of support by well-positioned agriculture companies and organizations, especially the commodity groups. However, other challenges are present, such as explaining the complex and time-consuming nature of new crop development. The assumption is often made that either new crops can be adopted on a large acreage overnight, or conversely, that new crops must not have merit because farmers are not already growing them. It is often anecdotes of success stories, rather than statistics on new crop need or potential that become the selling point to gain support. It can also be helpful to demonstrate the connection between new crop development and other politically "hot" issues, such as rural development or environmental protection. The end of crop commodity payments in 2002 is another issue that policy makers are thinking about, and provides a context for discussing the need for diversification.

Several policy steps are essential to encourage further new crop development. Foremost is gaining additional funding for research, education, and marketing programs on new crops. A key step in doing this has been getting Congress to authorize a national Thomas Jefferson Initiative for Crop Diversification, which provides a coordinated system for establishing regional new crop centers and authorizes grants on new crops. Appropriation support is still needed to make the Jefferson Initiative a reality. Funding needs to be long term as well, especially for germplasm development and plant breeding on new crops. The current trend for USDA funding is to make it all short-term, competitive grants, which is not an effective way of supporting breeding efforts, although short-term grants can work for other areas, such as utilization studies.

Several other areas need national policy changes. Federal crop insurance needs to be available. In some cases, farmers are not allowed to get an operating loan to grow a crop for which no crop insurance is available. Grain grading standards, or other federal market class guidelines, are needed for many new crops. Pesticide registration for new crops is very difficult because of their small acreage. EPA needs to be more flexible in extending pesticide registrations across crops. Lack of pesticide registrations means that in some cases organic or pesticide-free production methods must be developed. New crops need to be included in farm policies for conservation programs or export assistance programs to help level the playing field with commodity crops.

At the local level, institutional and company policies directly impact new crop success. Agricultural lenders must be flexible in supporting new crops. Equipment dealers must provide assistance in adapting equipment to new crops. Grain elevator managers must be willing to handle grains other than corn, soybeans, or wheat. In the case of non-grain crops, there needs to be delivery points and arrangements for marketing through food/crop brokers.

To be successful in overcoming these policy barriers, a variety of approaches will be needed. These include having a sustained contact with policy makers over a significant period of time, and providing success stories that can gradually develop a support base for new crops.

NEW CROPS VS. NEW USES

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Phasing out the Federal farm programs - and their associated financial security - may have done more than any single action in recent history to encourage the diversification into the production of alternative crops. Although this will provide a stimulus to diversify beyond traditional corn, soybeans, wheat, grain sorghum, cotton, and other previously "supported" crops, this is only part of the answer to the new crop's puzzle.

Historically, farmers have produced crops and sold them at the farm gate or perhaps the nearest local elevator with little regard and/or interest in what happened to them beyond that point. Although farmers received only commodity prices, at least there was a marketing infrastructure (transportation, processing, product development, etc.) that provided a demand for their raw commodities regardless of price. However, as we increasingly move toward alternative crops, the expectation of taking them only to the farm gate or the local elevator will result in failure in most instances. This is because many of the more promising new and/or alternative crops have no marketing and processing infrastructures to move them efficiently from the producer to the consumer.

Successful and sustained development of alternative crops will require coordinated development of the end product markets for both the primary products as well as their co-products, plus the processing and marketing system. This paper will share insights about various models in easing the development of these types of systems as well as share examples of some of those that have been most successful in creating new products and business opportunities. It will describe the organization and operation of those that have been most successful and identify the primary obstacles that have been overcome in the commercialization of new products.

In addition to identifying various barriers for marketing products derived from alternative feedstocks, it will also identify innovative ways of helping to streamline the movement of new products into the marketplace.

NEW USES FROM EXISTING CROPS

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In the last ten years, new uses from existing crops have been primarily driven by two technology improvements. The first is the use of enzymes for direct fermentation to convert the basic starch and oils produced by existing crops to higher value chemicals such as organic acids, amino acids, and vitamins. The second is the improvements in the physical and chemical separation processes by using resins and membranes, which allow the extraction of a relatively pure product from a complex media. In the next 10 years, these two technologies will be augmented with improvements in crop genetics, which should allow existing crops to produce improved and new products directly in the field.

These technologies should allow researchers and production companies to meet consumer needs for natural products in the neutriceutical area of "health through better eating" and in the health area for the production of basic pharmaceuticals. In the past, for the area of basic chemicals from natural products, the advantages of a "green" product have not shown consumer acceptance unless the product has superior properties or costs. The improvements underway in crop genetics should enhance this track record.

Using examples of the new products at ADM produced from fermentation, such as lactic acid, vitamin C, biotin and riboflavin, the advantages of the new fermentation and separation processes are examined. Also, the use of the new separation processes to extract the healthful components of existing crops, such as vitamin E and isoflavones has allowed these products to grow exponentially, following current medical research.

As basic crop genetics improves the seed, the requirements to translate successfully this advancement into a new product become critically important. Usually, the logistics of growing, collecting, and processing a new product and its byproducts from an existing crop has lagged behind the genetic improvement technology, and has hampered the growth of these products. How ADM, as a major processor, is working to improve the logistics is examined.

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BIODIVERSITY AND INDUSTRY OPPORTUNITIES

ORNAMENTALS: WHERE DIVERSITY IS KING-THE ISRAELI EXPERIENCE

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In the increasingly competitive international cut-flower and pot-plants market, novelty crops play an important role in maintaining and expanding market share. The ornamental industry is unique among the agricultural industries in that novelty is an important attribute. Customers always seek "something new." Even though the standard major ornamental crops will continue to constitute an important part of the market, a distinct trend toward increasing the share of "new crops" is clearly evident in recent years. These new products normally fetch higher prices than the traditional crops for a certain period, but quite often the prices drop when the market is saturated and the attraction novelty lessens. By that time, new products should be ready to enter the market. Research on introduction of new ornamental crops is, therefore an endless project.

The introduction of new crops includes many research stages that start with the initial search and screening and concludes when the product is introduced commercially. The introduction and adaptation of new exportable crops normally include the following stages:

A. Searching for potential crops

B. Selection and improvement

C. Developing propagation methods

D. Studying the growth and flowering physiology and developing practical means for their control

E. Evaluation of horticultural practices

F. Studying postharvest physiology and developing practical methods for postharvest handling, transport, and storage

G. Semi-commercial export shipments to markets abroad

Some major cut flowers in the European markets, which we introduced and developed in Israel, were "new crops" about 25 years ago, such as Gypsophila and Geraldton wax flower (*Chamelaucium uncinatum*). In this presentation, the development of these crops will be described as an example of successful projects.

HERBALS AND PHARMACEUTICALS: COMPETITIVE OR COMPLEMENTARY

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A steadily increasing number of herbal medicinal preparations are being tested in placebo-controlled competitive clinical trials with recognized pharmaceutical treatments. So far, in most reported cases, the herbal products are of comparable or superior efficacy and, almost invariably, associated with a significantly lower order of adverse side effects. Less scientifically supported are herbal applications, where fewer accessible endpoints for judgement of efficacy are involved.

Traditional remedies in the categories of tonics, adaptogens, and purported stimulants of the immune system seem complementary to conventional medicine. Selected examples will be presented to illustrate the dichotomy.

WHO WILL COMMERCIALIZE NEW INDUSTRIAL CROPS?

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In the last several decades of this century, we have seen an off-again, on-again aspiration to reinvigorate agriculture. The reason for this is that there have been problems, which include a declining rural population and economy, increasing energy dependency of agricultural production, and greater knowledge of the environmental impact of agriculture on soils, water, and air quality. Though solutions to these problems are complex and multifaceted, the two taken seriously at this conference are crop biodiversity and greater utilization of renewable crop products for non-food uses. Although both offer great hope ecologically and make sense, the business and economic realities of new crop and new use introductions make it a challenging task.

A key issue that will determine whether to modify genetically existing crops (i.e., soybeans, corn, canola, wheat) or expand efforts on domesticating and commercializing new species will depend upon whom the developers are. Good arguments can be made for both cases. Both paths have different risks/benefits and each will be pursued by different kinds of businesses. Currently, the initial development costs involving the bioengineering approach restrict the participants to large corporations. The consolidation among agrochemical and seed companies in recent months and years is indicative not only of the costs of such research, but also of the perceived rewards. Conversely, the domestication and development of entirely new species have been left to government agencies and special interest groups (usually growers themselves) who perceive either the indirect benefit of biodiversity in general or an economic reward for a specific market niche.

This debate will likely end with either a change in policy or a reduced cost of genetic engineering research. The genetic vulnerability of having much of the world's crop plants with similar genes for either chemical resistance or end-use characteristics could lead to rapid policy changes in research funding allocation. A more likely outcome may be the rapid development of genetic engineering know-how. The proliferation of knowledge could greatly reduce cost and make such technology easily accessible. Such an outcome may not only increase the number of businesses that may be capable of developing new crops and new uses, but it might also make such technology accessible to a larger number of species.

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PROCESSES AND STRATEGIES IN COMMERCIALIZING NEW CROPS AND NEW USES

SUPPLEMENTARY CASH CROPS IN A TOBACCO AREA

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The Specialty Crops Program was formed in July 1997 by a forward-thinking group of land-grant university scientists and extension workers, marketing specialists from the state department of agriculture, and leaders of the Alternative Crops Diversification Committee in Eastern North Carolina. Substantial new resources have been identified and committed to equipping a research station in Kinston, NC. These include state-of-the art production, cooling and packing line facilities for investigating opportunities to produce and market specialty fruits, vegetables, and herbs.

North Carolina is the leading state in the U.S. in the production of tobacco. Tobacco has permitted significant income to be realized from smaller and medium size farming units, and it is virtually impossible to identify alternative crops to "replace" 275,000 metric tons in annual tobacco production. This program's premise is that North Carolina farmers who now grow tobacco, corn, and soybeans may also wish to grow and sell high-value fruit and vegetable crops. At the 400+ acre Cunningham Research Station in Kinston, N.C., University scientists and technicians are working to generate information on the most efficient field and greenhouse growing systems for the specialty crops and varieties in greatest demand. Research station personnel involved in the program are highly motivated to find high-value alternatives as their own families have been growing tobacco for several generations.

The program's marketing component is a key element of the effort. A team of marketing specialists from the NC Department of Agriculture is helping growers to identify the product quality, volume and packaging requirements of national and regional supermarkets, food service buyers, and specialty food markets. The program has already succeeded in helping a group of tobacco farmers to form a grower association based in Kinston that is now shipping and test-marketing "Carolina Specialties." There is always a large measure of risk and a lack of security involved with new specialty crops. However, the market feedback of consumers and buyers to regionally produced specialties, including strawberries, peaches, specialty lettuces, orange and green-flesh cantaloupes, red and yellow seedless watermelons, and specialty peppers and squashes, is proving to be very positive. The main difficulty for the Specialty Crops Program is to cause a regional demand and a supply to come into existence simultaneously. However, the program's production and marketing teams reflect a willingness to change and a strength of purpose to initiate it.

ALTERNATIVE CROP DEVELOPMENT IN THE WESTERN HEMISPHERE TROPICS

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Goals and Objectives:

The goal of the U.S. Department of Agriculture, Agricultural Research Service (ARS), alternative crop program is to assist U.S. foreign affairs and other international donor organizations in reducing illicit narcotics production through alternative agricultural development. The program focuses upon integrated pest management with emphasis upon biological control of cacao diseases and coffee pests.

Targets of Activity:

Cocoa (Theobroma cacao) and coffee (Coffea spp.) are the two most common cash crops grown in illicit narcotic cultivation areas. Both crops are ideally suited to the needs of small farmers in remote areas due to their low volume, high storage life, and relatively high value per unit weight. Due to the labor-intensive requirements of the crops, both species are well-suited to low-wage, high-unemployment environments. Disease and pests represent the premier barriers to expansion of cultivation in the tropics. ARS' research, in cooperation with U.S. Department of State, U.S. Agency for International Development, and the Organization of American States, is oriented towards the exploration, characterization, and field evaluation of coffee and cocoa biocontrol agents in both laboratory and field conditions.

Cocoa is primarily affected by frosty pod rot (Moniliophthora rorei) in most of the Americas except Brazil, where witches' broom (Crinipellis peniciosa) is the major problem. Coffee is primarily impacted by the coffee berry borer (Hypothenemus hampei), which accounts for $2.1 billion loss annually in coffee crop worldwide.

The research approach for both Moniliophthora and Crinipellis is the identification and development of soil-borne inocula that will compete with cocoa pathogens. In the case of the coffee borer, the approach is the identification of a sufficiently aggressive parasitic wasp, e.g., Prorops nasuta, along with an effective technique for the mass-rearing of the host. The development of a cost-effective artificial diet is also in the process of being evaluated. To date, field trials have been initiated in Mexico, Colombia, and Peru to evaluate promising biocontrol candidate organisms.

NEW CROPS FOR CANADIAN AGRICULTURE

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In addition to developing new cultivars of well-known crops, Canada is interested in adapting foreign crops, developing undomesticated plants, and widening the uses for crops. Domination of the marketplace by the principle ancient, old-world domesticates has limited the diversity of crops in Canada. However, several considerations have combined to stimulate the exploitation of plants that are not currently significant. Recent changes in trade patterns have made diversification of the agricultural base desirable.

Anxiety over climate change has made it apparent that a long-term strategy based on a wide spectrum of plants is needed. Concern over the environment and the need to use marginal lands have made low-input sustainable agriculture desirable, for which different plants than currently cultivated are needed. Genetic engineering offers the prospect of adapting plants to grow in cool climates that up until now could only be raised competitively in warmer, more hospitable lands. Moreover, some of the vast areas of Canada currently considered unsuitable for agriculture may be possibly utilized. The growing realization that wild plants may be gold mines for industrial and pharmaceutical products also has stimulated interest in the search for new plant sources.

Many good possibilities exist for developing new crops in Canada. There has been recent interest in using fast-growing trees adapted to marginal lands as biomass, particularly as fuel. Modern transportation and international trade have resulted in a wealth of food plants being imported into Canada, limiting the prospects for new food crops. Nevertheless, there is a market for a few new specialty native food plants, such as saskatoon, ostrich fern, wild-rice, and a variety of indigenous berry crops. There is much more potential for domesticating wild plants as forages and fodders than as human foods. Possibilities include new legume and grass crops, development of native salt-tolerant Chenopodiaceae to take advantage of saline prairie province soils, and selection of *ecovars* of indigenous species that are well adapted to rangelands or semi-aquatic areas that support wildfowl hunting.

The breeding and economic development of canola are the best Canadian example of a *Cinderella crop,* and attempts are being made to develop other Brassica species as new oilseeds. Cannabis sativa is currently being resurrected as both an oilseed and a fiber plant in Canada. Some areas of Canada provide the isolated expanses necessary for seed production by bee pollination, and as a result, the seed industry is diversifying. Another promising area concern crops that contribute to the production of other crops, such as new legume green manures. Phytoremediation, the novel use of plants to reduce ecological damage, also offers the possibility of rejuvenation of lands for agricultural purposes. Greenhouse culture permits the growing of new high-value crops out of season. New ground covers and ornamentals are remarkably important in Canada. Cultivation and domestication of medicinal plants are also very promising, as are industrial crops.

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PANEL DISCUSSION

PERSPECTIVES ON THE USES OF PLANT INTRODUCTION

IN SITU PLANT CONSERVATION OF CROPS: ITS RELATIONSHIP TO PLANT EXPLORATION

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Plant genetic resources will continue to decline as viable plant populations unless communities are involved in protecting populations in situ. Economic botanists and new crop developers can play a role in supporting these efforts. Several case studies are offered as models for involvement.

PLANT INTELLECTUAL PROPERTY RIGHTS AND EXCHANGES

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An understanding of the different types of intellectual property rights (IPR) available to claim ownership in and protect legal rights to plant genetic materials is essential for today's agricultural researcher. An appreciation of the varying forms of protection available and the economic motivations for developing these legal rights help explain many of the changes occurring in the commercial seed and biotechnology industry and in the research sector. It is important to consider the effects and consequences-both intended and unintended-that the development of broad forms of IPR has on researchers and farmers. Several examples of current legal disputes over IPR claims in agriculture illustrate this potential. The use of production

contracts and other forms of closed production systems have an impact on the market and price discovery, and on the availability of parent materials and access to new production opportunities. The lack of either research or farm exemption in utility patents is also a concern.

THE FUTURE FOR PLANT GENETIC RESOURCE EXCHANGE

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If current trends can accurately forecast future developments, then plant genetic resource exchange may become ever more formal, complicated, time-consuming, slow, and expensive. The following may be among the most important causes for these trends: 1) the near ubiquity of material transfer agreements (MTA) and intellectual property rights (IPR) associated with germplasm exchange and perhaps even with information exchange; 2) national legislation governing germplasm access and benefit sharing, established in response to international biodiversity conservation treaties and trade agreements; 3) ever more frequent international travel and commerce that facilitate the spread of pests and pathogens, resulting in more stringent phytosanitary regulations for protecting plant health worldwide; 4) technological advances that enable certain regulations and practices associated with germplasm exchange to be enforceable; and 5) a shortage of resources for effectively discharging new responsibilities associated with genetic resource exchange. If the international community wants plant genetic resource exchange in the future to differ from this forecast, then it must develop ways for altering these trends. Otherwise, it must adjust to the challenges accompanying these trends.

LEGAL AND TECHNOLOGICAL MEASURES TO PREVENT FARMERS FROM SAVING SEED AND BREEDING THEIR OWN PLANT VARIETIES

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National and international institutions are employing a range of legal and technological measures to restrict farmers from saving seed and breeding their own plant varieties. In the process, agricultural biodiversity will further erode and the food security of at least 1.4 billion poor people who depend on farm-saved seed will be imperiled. Recent trends include, for example, the development of a genetic technique to sterilize seeds, the entry into force of UPOV 1991, and negotiations at the FAO Commission on Plant Genetic Resources for Food and Agriculture on "Farmers' Rights." Emerging trends in both the industrialized countries and the developing world will be presented.

Recent trends will be examined in the context of increasing consolidation in the life industry and the decline in public sector plant breeding. At present, the top 10 seed companies control 40% of the commercial seed market worldwide.

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STATUS OF NEW CROPS AND NEW USES

(A) NEW PRODUCTS FROM RENEWABLES

PAPER PRODUCTS FROM KENAF

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KP Products Inc., dba Vision Paper, has been producing and marketing paper products made from 100% kenaf fiber and from blends of kenaf fibers and recycled paper since 1992.

This discussion will cover key points in raw material quality, processing considerations, and creating market awareness including federal government purchasing issues.

U.S. KENAF PRODUCTION, PROCESSING, AND POTENTIAL

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Kenaf may be grown as a fiber crop in a broad range of soil types across the southern half of the United States. Total U.S. acreage of kenaf has increased steadily over recent years and is currently limited only by the demand for products made from kenaf. Proper herbicides and fertilizer in early stages of plant growth along with sufficient rainfall or irrigation during the entire growing season should insure acceptable yields.

The stalk of the kenaf plant consists of two primary parts -- the bast fiber and the core. The type and degree of processing necessary depend upon the intended use of the distinctive parts. Lower value uses for the whole stalk or chopped whole stalk also exist. Higher value uses come from separating the bast fiber from the core to high degrees of purity of each part. Different basic technologies are used for mechanical separation. Several operating facilities in the United States are capable of separating kenaf. The processing methods utilized vary according to fiber purity and capacity desired.

Potential for kenaf is practically unlimited due to its many uses. Kenaf is the solution for ever-increasing awareness of need for substitutes for wood and synthetic fibers. Most of the current demand for kenaf products is based upon price and performance without regard to the environmentally friendly impact from using kenaf. The most valuable existing commercial markets for the kenaf core include the specialty animal bedding and industrial absorbent. The greatest potential would lie in the industrial absorbent market due to larger size and growth of that market. Kenaf core is the best all-around granular biodegradable absorbent material available. The most valuable current uses for separated kenaf bast fiber include pulp and paper products, non-woven mat applications, and various composites.

HIGH PERFORMANCE 4-CYCLE LUBRICANTS FROM CANOLA

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Developing new crops and products is heavily dependent on market identification and the ability to provide a product to fill that niche at a price consumers can afford. Developing new crops frequently runs into the problem of supply and price. Therefore, the engine oil project based its development on a readily available source of oil, canola, and utilizes "new crop" oils to supplement canola's functionality. The project has four goals: an oil functionality equal to or better than current petroleum products; environmental safety and renewability; rural economic development; and cost competitiveness in a free market.

"Canola oil" can be defined as oil derived from Brassica species low in erucic fatty acids and low in glucosinalates. Two species currently meet this requirement: Brassica napus and Brassica rapa. Selections from B. napus for high oleic fatty acid content have provided a basis for extended oil life in engine applications. With the addition of unrefined vegetable oils and waxes, the viable use period of these oils has been extended. Initially, formulations for small engine tests tended to show marked increases in viscosity due to polymerization at 25 to 30 h. At that point in time, the oils gelled and the engine would not start. Currently, small engine tests under a full load have shown the engine capable of running up to 185 h without an oil change. Over 12,000 h have been logged in small engines using this oil.

Automotive tests have shown similar results. The extended life of the oil was required for automotive applications. Current oil analyses indicate no viscosity change in the oil up to 9,000 h between oil changes. A variety of SAE weight classifications have been developed ranging from SAE 30w to SAE 5w30. Preliminary data indicate an increase in fuel economy of these test vehicles ranging from 3 to 6%. This appears to be due to the improved lubricity of vegetable oils and reduced boundary friction of the oil. Independent laboratory tests indicate a boundary friction coefficient of 0.053 with a composite boundary friction coefficient of petroleum of 0.11. This indicates that it requires approximately one-half the energy to pump this canola-based oil compared to comparable petroleum and is lower than the boundary friction coefficients of synthetic motor oils. Automotive application trials have currently logged over 100,000 km.

Current modifications to the formulations have extended the range of the utilization of these oils. Pour point has been moved from 5 to -22 °C to meet cold weather requirements. Oxidative stability, as indicated by Rotating Oxidative Bomb Test, has been increased from 35 to 121 min, surpassing the goal of 120 min. In addition, the range of vegetable oils utilized in the formulations has been widened to increase availability and to compensate for potential shortages due to crop failure. Basically, formulations currently include sources of vegetable oils high in monoene fatty acids, natural and synthesized vegetable-based antioxidants, hydroxy fatty acids, and wax esters.

FLOORING FOR THE INTERMODAL TRANSPORTATION INDUSTRY FROM RENEWABLE, UNDERUTILIZED HARDWOODS

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Environmental Composite Products was formed to manufacture and market environmental friendly products using underutilized wood species and other forest and agricultural fibers. A major investor in this Company is the U.S. Department of Agriculture through its subsidiary the Alternate Agricultural Research and Commercialization (AARC) Center.

Market research conducted by the Company showed opportunities existed with respect to the development of a new flooring product for the intermodal transportation industry.

Users of intermodal container flooring have been confronted in recent years with a small number of southeast Asian companies controlling the supply side of the market, and ever increasing pricing structure and a building uncertainty of adequate supply of timber resource from the southeast Asian rainforest.

The domestic over-the road trailer market currently depends on hardwood laminate planking as its primary source of flooring product. Increased usage of domestic hardwoods by the furniture, cabinet, home flooring, and millwork industries, coupled with a high "trim loss" (+40%) and increased exporting of hardwood logs has resulted in a continuing escalation of prices for this product.

Enviro-Comp believes that the introduction of ALDTM (Advanced Laminate Decking) will be a major breakthrough in the intermodal flooring market. ALDTM is the solution to the intermodal industry's immediate need for a quality flooring product that is not tied to the increasing cost domestic laminate hardwood planking or to the harvesting of the world's remaining rainforest.

The Company looked at trailer and container floorings, two major segments of the overall intermodal flooring market. As a result of the Company's research and the perceived opportunities that existed for the introduction of new intermodal flooring products for both the trucking and container markets over the period of the next two years, the Company developed ALDTM. This new intermodal flooring product is composed of several underutilized U.S. hardwood species in conjunction with oak.

The raw materials needed to produce ALDTM are readily available, renewable, and relatively inexpensive. The Company has built and tested ALDTM in the panel configuration and has designed the lay-up for a Laminated Veneer Lumber (LVL) configuration. The Company is seeking an LVL partner to manufacture test quantities of ALDTM in the LVL configuration. It is currently in early discussions with several LVL manufacturing companies.

PARAFFIN ENHANCED MESQUITE AS A CHARCOAL REPLACEMENT

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Indian Creek Mesquite's primary product is the new 3.5 lb. "Light the Bag" mesquite chunk for home and outdoor use. The new "Light the Bag" concept for cooking with quality wood chunks provides an alternative to charcoal and eliminates the need for lighter fluids and chemicals sometimes associated with barbecuing. The mesquite wood chunks are coated with paraffin before being packaged in a highly specialized bag. This new concept combines environmentally friendly materials with a major, renewable forest resource to provide new opportunities for the outdoor cooking industry and to open new areas for crop production, which are currently being underutilized.

The use of green mesquite not only produces a far superior product, but allows for the thinning and proper harvesting of the resource. Thus, selected mesquite trees can grow larger and more valuable in a more healthy environment. This process of harvesting the forest resource will not only produce trees that are more useful in the industry, but will provide additional open areas for native grasses to grow for livestock production.

Again, outdoor chefs simply place the "Light the Bag" product on the grill, thus eliminating lighter fluid and other polluting chemicals normally used in outdoor cooking. The fire is ready in 15 to 20 minutes.

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(B) FRUIT AND NUT CROPS

NEW ARID LAND FRUIT CROPS

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The Israeli Negev Desert is the only place where further agriculture industry can be developed. Due to market competition, very high input prices, and scarcity of water, common crops cannot serve as the future agricultural crops in Israeli. Thus, many wild and rare fruit trees were introduced into various locations in the Negev Desert, which are varied in their environmental conditions. Among the introductions, two cacti have already made their way into the European market.

Two genera of climbing cacti from the tropical and subtropical shady habitat were developed to grow either in greenhouses to avoid subfreezing temperatures or under shade-houses to avoid damaging photon flux densities. These cacti are *Selenicereus megalanthus*, (known in Colombia as yellow pitaya) or *Hylocereus undatus*, *H. polyrhizus*, and unidentified species *H.* sp. (known as red pitayas). They were sold in local markets and in Europe for the first time in 1996 and 1997. Total exported yields were 10 and 25 tons in 1996 and 1997 respectively, with the highest prices ever obtained from exported fruits in Israel. To enable efficient production, studies of all aspects of horticulture including irrigation and breeding are carried on at BGU. The Israeli name of these fruits is EDEN fruits.

Cereus peruvianus, a columnar, outdoor-grown cactus, went through a similar domestication process. Its fruit was sold for the first time in Europe in 1997 under the name Koubo. The farm-gate-price of 7 US$/kg was far beyond any common fruit crop prices exported from Israel. The names Koubu and Eden were given to avoid the use of the name pitaya, which covers many species and genera. These pitayas differ from each other like peach from apple and pear. These new developments support the hypothesis that new crops can serve as a remedy to the troubled Israeli export market and that a viable agriculture industry is feasible under the harsh conditions of the Negev Desert of Israel.

NEW OR FORGOTTEN TEMPERATE BERRY CROPS

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With few exceptions, wherever humans have lived, they have made berries a part of their diet. Although most of these berries have never been developed beyond local interest, several have become major crops. For the purposes of this discussion, the berry crops have been divided into four groups based on their current popularity worldwide.

The most important berry crops worldwide include strawberry (*Fragaria ananassa* Duch.), blueberry (*Vaccinium corymbosum* L., *V. angustifolium* Ait., *V. ashei* Reade), cranberry (*V. macrocarpon* Ait.), black currant (*Ribes nigrum* L.), table and wine grapes (*Vitis* spp.), and raspberry (*Rubus idaeus* L.).

The next group of berry crops comprises those that have major acreages worldwide and are very important crops, but for a variety of reasons have not reached the stature and importance of the first group. These are the blackberry and hybrid berries such as 'Logan' and 'Boysen' (*Rubus* sp.), black raspberry (*R. occidentalis* L.), lingonberry (*Vaccinium vitis-idaea* L.), gooseberry (*Ribes* sp.), and red currant (*Ribes* sp.).

A third group includes crops that are regionally important such as *Abronia* (*A. melanocarpa*), purple raspberry (*Rubus* sp), cloudberry (*R. chamaemorus* L.), arctic raspberry (*R. arcticus* L.), mora (*R. glaucus* Benth.), alpine strawberry (*F. vesca* L.), muscadine grapes (*V. rotundifolia* Mich.), Juneberry/saskatoon (*Amelanchier* sp.), hardy kiwi (*Actinidia arguta* Miq.), edible honeysuckle (*Lonicera caerulea* L.), sea buckthorn (*Hippophae rhamnoides* L.), elderberry (*Sambucus canadensis* L.), and Schizandra (*Schizandra chinensis*).

The fourth group consists of crops that have great potential as cultivated crops, but are more commonly harvested from native stands. Some examples include trailing blackberry (*R. ursinus* Cham. & Schldl.), huckleberry (*Vaccinium* sp.), bilberry (*V. myrtillus* L.), Cornelian cherry (*Cornus mas* L.), mountain ash (*Sorbus* sp.), and buffaloberry (*Shepherdia argentea* Nutt.). Although the species included in these groupings are by no means all inclusive of potential commercial berry species, they probably represent the most likely candidates to have an impact on the world markets in the near future.

Whether any of these develop into a major crop depends on many factors that have been discussed in the past by presenters at this conference. Success can be unpredictable. In 1975, George Darrow gave equal opportunity to two potential new crops, *Viburnum trilobum* Marsh. (American highbush cranberry) and *Actinidia arguta* (hardy kiwi). Nearly 25 years later, A. arguta plantings are expanding rapidly and there is a small, international, fresh market industry based on this crop. In contrast, *V. trilobum* is widely sold for the landscape industry, but no substantial industry based on this crop has developed.

The rising interest in the nutraceutical characteristics of the foods we eat has carried over to berries. For example, Schizandra and bilberry are two crops that are primarily harvested for their nutraceutical potential.

A brief overview of the current status and future potential of most of these crops will be presented.

NEW TEMPERATE FRUIT: ACTINIDIA CHINENSIS AND ACTINIDIA DELICIOSA

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The development of new temperate fruit crops will be considered using the kiwifruit as an example. It is already an established crop although of very recent origin. Other *Actinidia* species could soon be the basis of new industries.

The kiwifruit, *Actinidia deliciosa*, is one of the very few temperate fruit crops to have been domesticated this century. In less than 100 years, the kiwifruit has gone from being a wild plant in China to a plant grown commercially in many countries. The process of domestication is more than simply transferring a plant from its homeland to new countries. It includes learning how to manage the plant, getting it to crop consistently and profitably, and developing a market for a previously unknown crop.

The kiwifruit industry that first developed in New Zealand is based on cultivars derived from a single importation of seed. One fruiting cultivar, 'Hayward', has large fruit and its flavor and storage is superior to other cultivars. Their long storage life allowed the successful development of the New Zealand kiwifruit industry. The success of the New Zealand industry encouraged growers in other countries to start growing kiwifruit. They also initially used the cultivars from New Zealand. 'Hayward' remains the predominant cultivar throughout most of the world although one fruiting cultivar, 'Qinmei', has been widely planted in China.

Simultaneous flowering of 'Hayward' and a pollenizer are required for the production of commercial-sized fruit. The relative timing of flowering of 'Hayward' and individual male genotypes depends on climatic conditions. During the spring, different pollenizer cultivars had to be selected for different kiwifruit growing areas to ensure adequate pollination of 'Hayward'.

'Hayward' is one cultivar of one botanical variety of one species of *Actinidia*. The genus contains more than 60 species and about 100 distinct taxa offering great variety in growth habit and fruit attributes. This variation offers great scope to plant breeders, but, in addition, several species have commercial possibilities in their own right. The most promising of these is *A. chinensis*, a cultivar now grown in several countries as well as in its homeland, China. Further development will lead to cultivars differing in appearance, size, flavor, and flesh color. Selection of a new cultivar is only the first step. Work is then required to enable that cultivar to be grown, managed, and the fruit harvested, stored, and marketed.

The lessons learned from the development of the kiwifruit industry, particularly its rapid expansion over the past 20 years, will help in the development of new kiwifruit industries based on cultivars of other *Actinidia* species.

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(A) OILSEEDS AND INDUSTRIAL CROPS: INDUSTRY APPROACH

EPOXY OIL FROM VERNONIA FOR PAINTS AND COATINGS

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Previous work with vernonia oil has demonstrated that this material could be used in coatings to produce films that were crosslinkable with ultraviolet radiation. The vernonia oil itself could be used to form a coating or the oil could be used in combination with functional acrylics. The films produced were found to have good solvent resistance and flexibility, but very low gloss.

As an extension of this work, we began to investigate ways to improve the gloss of these coatings. The approach taken included blending of vernonia oil with a wider range of acrylics. In general, these acrylics contained functionality that would react with the epoxy functionality of vernonia oil to produce a cured film. The films produced had excellent solvent resistance. The gloss was significantly improved in comparison to that of the films previously studied.

In addition to functional acrylics, blends of vernonia oil with other functionalized oils were made. Like the acrylics, the oils contained functionalities capable of reacting with the vernonia oil to yield cured films. The solvent resistance and gloss of these films were also very good.

A SEED COMPANY'S PERSPECTIVE ON THE CREATION OF NEW AND ADDED VALUE FOR CROPS

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Efforts to capture greater value from agricultural field crop products may be approached in many ways. Management of production practices can lower attendant costs. This is being augmented by transgenic modification of crops to lower input costs for growers. Processing efficiencies can be improved by millers, crushers, and others who fractionate harvested grains and oilseeds to supply end-use markets.

Processors are increasing the range of products they offer through isolation of more components from their input. In addition, new value is being created through subsequent manipulation of isolated materials through processes such as fermentation by which low-cost inputs are transformed into relatively higher valued products. Value may also be created by altering the composition of harvested seeds such that they become inherently more valuable. This may be accomplished by altering metabolic fluxes to increase the proportion of components of higher value at the expense of those with lower value. Similarly, metabolic fluxes may be diverted to produce novel molecules otherwise absent from the seed. This process can be integrated with the needs of industrial end users so that the genetic modification of seeds is specifically targeted to end-use markets. This offers many new production opportunities for growers as well as new renewable sources for consumers of industrial chemicals.

I will review some of Pioneer Hi-Bred's activities in synthesizing novel molecules in maize grain as we move to create new markets and opportunities for agricultural producers and industrial chemical consumers.

THE VALUE CHAIN FROM CROPS TO CHEMICAL SPECIALTIES

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Chemical specialties are those small ingredients that provide a disproportionate level of performance in the chemical systems in which they are used. Examples of this include thickeners for paints, strengthening polymers for paper systems, and gelling agents in food systems-all of which are typically used at concentrations of 2% or less.

Plant-based raw materials have traditionally provided an exceptional level of functionality; indeed, more than 60% of Hercules' business is based upon these materials. The three basic classes of plant-based raw materials are: storage compounds, cell wall materials, and secondary metabolites. The value chain for transforming each of these classes of material into specialty chemicals is somewhat different, and dictates whether a viable product is possible. This talk will cover some of the basics of the value chain, as well as issues of raw material and product heterogeneity, manufacturing cost, and end-use value.

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(B) VEGETABLES AND NUTRICEUTIALS

NEW ALLIUMS CROPS AND THEIR RELATIVES

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Except for a few religious or geographically isolated cultures, all of the world's peoples eat representatives of the Alliums. The better known examples are the bulb onion, potato onion, and shallot (all *Allium cepa*), garlic (*Allium sativum*), leek (*A. ampeloprasum* var. *porrum*), and chive (*A. schoenoprasum*).

Many other Alliums are cultivated in specific areas of the world or by specific cultures and are less commonly known, e.g., the top-setting onion (*A.* x *proliferum*), Chinese chive (*A. tuberosum*), great-headed or elephant garlic (*A. ampeloprasum* var. *holmense*), kurrat (*A. ampeloprasum* var. *kurrat*), French grey shallot (possibly *A. oschaninii*), and Japanese bunching onion (*A. fistulosum*). Also throughout the world, many locally cultivated or collected Alliums are consumed (e.g., *A. nutans*, *A. ursinum*, and *A. oschaninii*).

Ornamental Alliums are economically important, the main examples being *A. aflatunense*, *A. caesium*, and *A. giganteum*. New cultivated types of ornamental Alliums are appearing, e.g., *A. schubertii* or *A. unifolium*, and may become economically important. New asexually propagated Allium crops may reach economically significant sales, such as an interspecific hybrid between the bulb onion and garlic.

NEW VEGETABLE CRUCIFERS

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Vegetable crucifers comprise a fantastic, morphologically plastic array of edible forms with considerable economic and nutritional significance worldwide. The genus *Brassica* is particularly well-represented, but other genera (*Armoracia, Eruca, Nasturtium, Raphanus*) contribute as well. Depending on the specific crop, edible portions include root, stem, and leaf tissues, immature and mature reproductive organs, and seeds - even the entire plant in the case of sprouts. Preparation for consumption is equally diverse, including raw, cooked, and preserved forms. The multiplicity of cultivated types highlights the incredible phenotypic diversity within and among species, but greatly confuses botanical nomenclature and common names.

In textbook examples of convergent domestication, identical morphotypes have been independently selected in several different *Brassica* species during domestication in Europe and Asia. Introductions of exotic vegetable crucifers into retail markets, seed companies, restaurants, etc. have vastly increased the availability of various vegetable crucifers for consumers. Recently, vegetable crucifers have commanded increased interest for their potential health-promoting and disease-preventative properties. The genetic potential of crucifers exploited through conventional plant breeding and selection is impressive, but their future improvement via biotechnological approaches offers an even more exciting future.

NEW SOLANUMS

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Two "new" solanums are now among the world's important crops. The tomato (*S. lycopersicum*) and the tree tomato (*S. betaceum*) have recently been restored to the genus *Solanum* as a result of molecular systematic studies. The tree tomato, native to the Andes, is now grown in New Zealand and it is widely exported. The pepino (*S. muricatum*), another Andean native also grown and exported from New Zealand, is presently attracting attention as a potential crop plant in Spain and several other countries. Moreover, increased interest in it has recently been shown in South America, particularly in Chile.

Recent research indicates that the pepino probably had at least two species involved in its origin that would help account for its great variability. The naranjilla (*S. quitoense*) and the cocona (*S. sessiliflorum*), both native to northern South America where they are much appreciated, are not yet exported in spite of many desirable features. The cocona is cultivated in the upper Amazon basin, whereas the naranjilla has a more limited distribution, mainly in Ecuador, Colombia, Panama, and Costa Rica, at slightly higher elevations. Nematodes and diseases have limited its cultivation. In recent years, there have been promising developments with the naranjilla. In Ecuador, a hybrid between the cocona and the naranjilla has proven superior to the naranjilla and largely replaced it. In Colombia, a nematode resistant form of the naranjilla has been developed by incorporating resistance from the wild species, *S. hirtum*. A few comments will be made concerning the eggplant, tomatillo, and chili peppers.

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(A) OILSEEDS AND INDUSTRIAL CROPS: GENETIC APPROACH

THE FUTURE OF NEW AND GENETICALLY MODIFIED OIL CROPS

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The past decade has witnessed dramatic developments in the manipulation of oil crops using both the conventional breeding and transgenic approaches. Within the last few years, several new genetically-modified varieties of soybean and rapeseed have been released for commercial production. Despite these successes, considerable scientific, commercial, and agronomic challenges remain for the widespread cultivation of new or genetically-modified oil crops. Scientific challenges include development of high levels of specific fatty acids in seed oils and the prevention of fatty-acid recycling during oil synthesis. Another major challenge is to increase seed-oil yield.

The recent advent of genomics with the application of molecular marker technology, coupled with large scale genome sequencing programs, has revolutionized our ability to manipulate complex traits such as oil yield and fatty-acid composition in plants. The application of this technology to the major annual oilseed crops and its extension to other perennial oil crops such as oil palm will be discussed, together with challenges associated with the management of identity preservation in transgenic crops. Alternative strategies for the rapid domestication of new oil crops with commercially useful fatty-acid profiles will also be explored. Together, these developments promise to have a major impact on the production of oleochemicals, whether for industrial or edible use in the 21st century.

TRANSGENIC OILSEEDS: TRANSITION FROM BASIC RESEARCH TO COMMERCIAL PRODUCTS

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Two varieties of rapeseed are commonly cultivated in the U.S. and Canada. The oil extracted from high erucic acid rapeseed (HEAR) oil is used for industrial applications and contains 40 to 50% erucic acid. The remaining fatty acids are primarily 18 carbon unsaturates. Canola oil, a food oil derived from low erucic acid rapeseed (LEAR), is composed primarily of 18 carbon unsaturated fatty acids. Several features of rapeseed make it ideal for production of transgenic oil; it is a widely grown agronomic crop; it has high oil yields; it has and infrastructure for production and crushing of identity preserved oils; and it is easily transformed.

One of the first uses of transgenic technology to modify seed oil was the expression of a laurel-ACP thioesterase from the California Bay tree in plastids of canola embryos. This resulted in the redirection of fatty acid synthesis from 18 carbon fatty acids to 12 carbon fatty acids. During the past several years, the thioesterase technology has been extended to the isolation of thioesterases with preferences for acyl-ACPs with different chain lengths. Transgenic oils rich in short chain (8 and 10 carbons) fatty acids, myristate (14 carbons), and palmitate (16 carbons) have been produced using thioesterases derived from various plant species. These transgenic oils represent new agronomic sources of these fatty acids and triglycerides containing these fatty acids.

The manipulation of fatty acids to chain lengths greater than 18 carbons required the isolation of genes encoding microsomal membrane proteins. A condensing enzyme (b-ketoacyl-CoA synthase, KCS) from the microsomal fatty acid elongation pathway of jojoba was isolated. When introduced into transgenic LEAR, it complemented the mutations that differentiate HEAR and LEAR. The jojoba gene is in use as part of a strategy to increase the erucic acid content of HEAR. Oil extracted from honesty, Lunaria annua, contains about 25% nervonic acid (24 carbons). The KCS gene was isolated from a Lunaria embryo cDNA library. Its expression in transgenic HEAR has resulted in the accumulation of nervonic acid in rapeseed oil. This represents an agronomic source of a hitherto rare and expensive fatty acid.

The structure of triglycerides is controlled by the acyltransferases that esterify fatty acids to the glycerol backbone. In most temperate oilseed crops, the acyltransferases catalyzing the transfer to the outer positions have broad substrate specificities. The sn-2 acyltransferase, however, only recognizes 18 carbon unsaturated fatty acids. The substrate specificity of the sn-2 acyltransferase is responsible for the unique triglyceride structure of the transgenic rapeseed oils and represents an advantage in the production of new oils. The specificity is a disadvantage when trying to improve the yield of saturates or very long chain fatty acids. Genes encoding sn-2 acyltransferases were isolated from coconut and meadowfoam. The coconut acyltransferase inserts laurate and myristate in the sn-2 position of transgenic oils, and the meadowfoam acyltransferase inserts erucic acid in the sn-2 position of transgenic oils. These acyltransferases, in conjunction with other genes of the oil biosynthesis pathway represent opportunities to increase the composition of unusual fatty acids to very high levels in transgenic oils.

THE DEVELOPMENT OF NOVEL OILSEED CROPS

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Plants produce a stunning variety of fatty acids, the building blocks of seed oils, and are a rich source of renewable industrial chemicals and fuels. Although more than 300 fatty acids are found in nature, less than 10 are produced on a significant commercial scale. This is partly because non-renewable feedstocks (e.g., petrochemicals) have dominated the industrial marketplace. Also, most of the unusual fatty acids found in nature are produced by undomesticated species, many of which have limited promise as crop plants. Crop domestication and genetic engineering are two ways to access the chemical diversity of these species.

Crop domestication is viewed by some as being less glamorous than genetic engineering, but has an important role and place in society. Newly domesticated plants create commercial opportunities and commerce for rural communities, supply chemical feedstocks and products to market sectors that shun genetically engineered products, increase agricultural biodiversity, and create economic incentives to collect and preserve germplasm. These crops can provide farmers in developed and underdeveloped countries with opportunities to produce industrial crops without having to pay a premium for gene discovery and engineering. Industrial crops are grown on 1/5 of the arable land in the world and are a vital source of income for farmers in less developed countries. This philosophy has fueled the development of *Cuphea viscosissima* Jacq. and meadowfoam (*Limnanthes alba* Benth.) as crop plants. The role of breeding and genetics in the development of *Cuphea* and meadowfoam as crop plants is described in this paper.

Seed shattering has been and still is the primary constraint to commercially producing *Cuphea* for commodity markets. The other constraints (seed dormancy, cross-pollination, and sticky hairs) have been eliminated through breeding, and the essential traits (non-dormant seeds, non-sticky hairs, and self-pollination) have been combined with a partially non-shattering trait to create the first commercial cultivars of *Cuphea*. These cultivars can be machine harvested and are being increased for field tests. They should produce sufficient yields for the crop to compete in specialty markets. The partially non-shattering trait should be sufficient for recovering a significant fraction of the seed produced throughout the growing season; however, the development of completely non-shattering lines will be essential for producing *Cuphea* for the commodity markets.

Meadowfoam is commercially grown in Oregon and is not constrained by wild species traits, but is constrained by low seed yield (a combination of low biomass and poor pollination). The primary focus of our breeding program has been to increase seed and oil yields by selecting for increased seed yield and oil content such as self-pollination, 1,000-seed weight (cross-pollinated germplasm only), plant height, and stem strength. This work has led to several new cultivars, which should boost meadowfoam seed yields.

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(B) FLORAL CROPS

NEW FLOWER CROPS

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Ten years ago, the traditional major crops constituted more than 60% of the cut flowers grown in and exported from Israel. This year, however, more than 60% of the exportable flowers are "new crops" that were not grown commercially 10 years ago.

Several sources serve for introduction of new plant material as potential ornamental crops:

A. Minor field cut flowers used mainly during their natural flowering season (normally in the summer). Their introductions require developing physiological and horticultural techniques for out-of-season production. Examples are: *Aconitum*, *Asclepias*, *Achillea*, *Echinops*, *Eryngium*, *Liatris*, *Phlox*, *Trachelium*, *Solidago*, and Peony (*Paeonia*).

B. New cultivars of minor field plants with modified and improved physiological and horticultural traits. Examples are: *Lisianthus* (*Eustoma*), *Anugozanthus*, *Campanula medium*, *Limonium*, *Aster*, *Closia*, and *Godetia* (*Clarkia*).

C. Plants used mainly in the garden and landscaping. Examples are: *Hypericum*, *Cotinus*, and *Ruscus hypophillum*.

D. Plants used as field and vegetable crops. Examples are: sunflower, cotton, and safflower (*Carthamus*).

E. Plants grown in botanical gardens and specialized plant collections, Examples are: *Bulbinella* and *Ornithogalum dubium*.

F. Native plants in their natural habitat. Some examples of such plants that are currently under intensive developmental stages will be presented. They include plants originated from remote areas, but also plants native to Israel and California.

PROTEACEOUS FLORAL CROPS; BREEDING NEW CULTIVARS AND UNDEREXPLOITED USES

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The Proteaceae is primarily a southern hemisphere family. Most of its 82 genera are native to South Africa and Australia, and others to New Zealand, South America, Malaya, Pacific Islands, and other African regions. Many diverse types are relatively unknown outside South Africa and Australia. This paper discusses the genera *Protea*, *Leucospermum*, *Leucadendron*, *Banksia*, *Grevillea*, *Telopea*, *Serruria*, and *Persoonia*, and explores their uses as cut flowers, cut foliages, landscape plants, and potted plants. Climatic preferences and cultural recommendations are presented. The results of research conducted in Australia, Israel, South Africa, and Hawaii are reviewed.

Leucospermum is the most widely grown genus for cut flower production. The cultivar development program at the University of Hawaii is discussed, including the influence several species have had on plant structure, stem length and diameter, leaf size, and disease resistance.

NEW ARID LAND ORNAMENTALS: RECENT INTRODUCTIONS FOR DESERT LANDSCAPES

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Over the past decade, water conservation has become an increasingly important issue across the southwestern United States. This concern has led local horticulturists and landscape architects to explore the use of water-thrifty ornamentals from dry climates throughout the world. The Chihuahuan and Sonoran deserts in particular have yielded a vast array of successful landscape plants. Universities, growers, and plant enthusiasts have all participated in the collection, propagation, evaluation, and promotion of new plant introductions.

A group of recent proven introductions, including trees, shrubs, ground covers, and perennials will be presented. Information will be provided on their origins, growth habits, cultural requirements, and potential uses in the landscape.

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(A) FIBER AND ENERGY CROPS

CELLULOSIC FEEDSTOCKS FOR FUELS AND POWER: THE U. S. DEPARTMENT OF ENERGY'S BIOENERGY FEEDSTOCK DEVELOPMENT PROGRAM

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The successful development of biomass energy systems requires a unique level of cooperation among researchers and institutions in the energy, agricultural, forestry, and environmental sectors. The Bioenergy Feedstock Development Program (BFDP) is fostering alliances to advance the development and demonstration of cellulosic feedstock production systems. It supports the missions of the Department of Energy's (DOE) biofuels and biomass power programs and is closely integrated with DOE's conversion research programs coordinated by the National Renewable Energy Laboratory. Major components of the BFDP include energy crop development, environmental research, systems integration and analysis, bioenergy market development, and information and data services.

The BFDP's energy crops research emphasizes short-rotation tree crops in the genus *Populus* (primarily poplars and cottonwoods) and switchgrass (*Panicum virgatum*). It is organized around crop development consortia consisting of universities, U.S. Department of Agriculture research units, and industrial cooperators. Its environmental research, designed to ensure that feedstock production systems are sustainable and environmentally beneficial, emphasizes water quality impacts, soil sustainability, carbon sequestration and cycling, and biodiversity.

The BFDP includes systems integration and analysis to provide timely and relevant information to public and private organizations who are interested in biomass energy development. Work in this area incorporates results from all BFDP research areas. It supports short-term information responses and the longer-term development of databases and analytical tools. To facilitate collaboration with other organizations interested in bioenergy, the BFDP strives to use existing and accepted models, databases, and methods, especially those used by the U.S. Department of Agriculture. The BFDP also provides a consistent contact for industries needing information on feedstock and market development at the larger scale. Data and information from experiences with larger-scale feedstock supply systems are, in turn, fed back into the program's research and analysis elements. With an increasing number of individuals and organizations assessing the potential importance of biomass energy, the BFDP places a strong emphasis on providing consistent and documented data and information.

DEVELOPING SWITCHGRASS AS A BIOENERGY CROP

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Over the past seven years, research designed to evaluate and improve switchgrass (*Panicum virgatum*) as a bioenergy crop has been conducted by a team of government and university researchers in the Southeast and central United States. This effort is part of the DOE-sponsored Bioenergy Feedstock Development Program at Oak Ridge National Laboratory and has been focused in the areas of yield improvement through management and breeding, physiological and genetic characterization, and applications of biotechnology for regeneration and breeding research.

Switchgrass, a warm-season prairie grass, was chosen as the model species because of its perennial growth habit, high yield potential, compatibility with conventional farming practices, and high value in improving soil conservation and quality.

Variety trials centered in Virginia, Alabama, and Texas have identified three excellent high-yielding switchgrass varieties. The varieties include Alamo, in the deep South, Kanlow at intermediate latitudes, and Cave-in-Rock for the upper Midwest. Yields of fully established stands of the best adapted varieties have averaged approximately 16 Mg a^{-1} across 18 testing sites. Minimum costs of \$1.78-\$2.03 $MBtu^{-1}$ have been estimated for farm-scale production in the Southeast. Management research has been directed at documenting nitrogen, row spacing, and cutting regimes to maximize sustained yields. Significant gains in soil carbon have been documented for switchgrass across a wide range of sites. Also, associated gains in soil quality and erosion control are anticipated in connection with long-term production of this species.

Breeding research has focused on developing and characterizing an extensive GERMPLASM collection, characterizing breeding behavior traits, and both narrow and broader base selection for yield improvement for both marginal and quality soils. Tissue culture techniques have been developed to permit rapid clonal propagation of select switchgrass lines and to offer opportunities for application of advanced biotechnological techniques. Energy budgets indicate that significant gains in energy return and carbon emissions reduction can be achieved with switchgrass as a biofuel.

AGRONOMIC RESEARCH ON HEMP IN MANITOBA

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Industrial hemp (*Cannabis sativa* L.) research was carried out in Manitoba in 1995-97 as a joint effort by provincial government, farm, industry, and university cooperators. The objectives were to evaluate the adaptation of available cultivars for fiber and seed production, monitor for potential insect and disease problems, gain some initial experience with the crop using field-scale equipment, evaluate the quality of Manitoba-grown hemp for various end uses, and estimate the cost of production and economic feasibility of hemp crops in Manitoba. Field trials consisting of replicated small-plot experiments and 1 to 5 acre blocks were conducted at four or five locations in each of the three years. Laboratory analyses were used to determine fatty acid and protein profiles for seed oil and meal. Varieties were obtained from the Ukraine, Poland, Hungary, Romania, and France.

In small-plot trials, stalk yields (at mid-flowering) ranged from 4,500 to 11,100 kg/ha, and grain yields ranged from 700 to 1,900 kg/ha. Experience on larger blocks suggests that 700 to 800 kg/ha (clean, dry basis) should be regarded as the target grain yield for the varieties presently available, but even a yield of 300-400 kg/ha would represent a good experience for a first-time grower. Early cultivars matured to seed in approximately 120 days, whereas later cultivars would have required up to 150 days to mature. Seed oil quality was deemed good, with an approximate 3:1 ratio of omega-6 to omega-3 fatty acids, gamma-linolenic acid content as high as 3.8% depending on the cultivar, and relatively high levels of antioxidants.

Field-scale experience with readily available seeders, mowers, balers, and combines was good, although modifications to some equipment to improve effectiveness will undoubtedly accompany increasing commercial production. Numerous insect species were present, but only the Bertha armyworm (*Mamestra configurata*) resulted in economic damage. The disease organism *Sclerotinia sclerotiorum* caused significant stem rot under some circumstances. THC content was less than 0.3% for most cultivars, but for some (particularly of Hungarian and Romanian origin) levels more than 0.3% were frequently obtained, suggesting that these cultivars may have difficulty meeting regulatory requirements for production in Manitoba. We conclude that hemp production in Manitoba is most feasible as a dual-purpose scenario (grain and residual stalk), and that, contrary to much of the literature promoting hemp cultivation, hemp production will not be without management challenges. Now that regulations have been implemented in Canada that permit licensed commercial cultivation of industrial hemp, the 1998 growing season in Manitoba will see continued research activity in support of this crop, as well as a concerted effort to learn as much as possible from the early commercial cultivation experience.

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(B) AROMATIC SPICES AND MEDICINALS

HERBS AFFECTING THE CENTRAL NERVOUS SYSTEM

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Scientific and clinical investigations conducted in recent years have identified a number of botanicals that produce significant effects on the human central nervous system (CNS). Various preparations of these herbs are currently sold in the United Stares as dietary supplements. As such, no therapeutic claims may be made on the label, but under the Dietary Supplement Health and Education Act of 1994, information regarding their action on the structure and/or function of the body is allowed.

Details of the most significant herbs in this category are discussed. These include a concentrated and purified extract of the leaf of *Ginkgo biloba* (ginkgo) employed in the treatment of various cognitive deficiencies. A standardized extract of *Hypericum perforatum* (St. John's wort) has

become a very popular treatment for mild to moderate depressive states. *Piper methysticum* (kava), long used in Oceania as a relaxant and more recently in Europe as an effective anxiolytic, is now widely marketed in the United States. Valerian (*Valeriana officinalis*) is an effective treatment for restlessness and sleep disturbances.

Several other herbs reputed to cause a depressive effect on the CNS include *Humulus lupulus* (hops), *Melissa officinalis* (lemon balm), *Passiflora incarnata* (passion flower), and *Lavandula angustifolia* (lavender). The data supporting the effectiveness of these minor sedatives are presented and discussed briefly.

IMMUNE STIMULANTS AND ANTIVIRAL BOTANICALS: ECHINACEA AND GINSENG

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The scientific data in support of immunostimulant and antiviral activities of echinacea are examined, especially with respect to its claimed effectiveness in abating the symptoms of cold and flu. Particular attention will be given to species differences relating to content of recognized actives, and to the differing character of formulations and different modes of administration.

Support for the traditional medicinal reputation of ginseng by modern studies based mainly on ginsenoside-rich extracts will be evaluated.

NEW ANTIMICROBIALS OF PLANT ORIGIN

Maurice M. Iwu[1], *Angela R. Duncan*[2], and *Chris O. Okunji*[3]

[1]Bioresources Development and Conservation Programme, Nigeria; [2]Axxon Biopharm. Inc. Silver Spring, MD, USA; [3]Division of Experimental Therapeutics, Walter Reed Army Institute of Research, Washington, DC USA

Infectious diseases account for approximately one-half of all deaths in tropical countries. In industrialized nations, despite the progress made in the understanding of microbiology and their control, incidents of epidemics due to drug resistant microorganisms and the emergence of hitherto unknown disease-causing microbes pose enormous public health concerns.

Historically, plants have provided a good source of anti-infective agents; emetine, quinine, and berberine, remain highly effective instruments in the fight against microbial infections. Phytomedicines derived from plants have shown great promise in the treatment of intractable infectious diseases including opportunistic AIDS infections.

Plants containing protoberberines and related alkaloids, picralima-type indole alkaloids and Garnia biflavones, used in traditional African system of medicine, have been found active against a wide variety of microorganism. The profile of known drugs like *Hydrastis canadensis* (Goldenseal), *Garcinia kola* (bitter kola), and *Polygonum* spp., *Aframomum melegueta* (grains of paradise) will be used to illustrate the enormous potential of anti-infective agents from higher plants. Newer plant drugs such as *Innuendo chlorantha*, *Xylopia aethiopica*, *Araliopsis tabouensis*, *Cryptolepis sanguinoleta*, *Chasmanthera dependens*, and *Nauclaea* species will also be reviewed.

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PANEL DISCUSSIONS

SOURCES OF PUBLIC FUNDING

Carmela Bailey (Moderator)

USDA-CSREES, Washington, DC, USA

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Dwayne Buxton, (National Program Staff, USDA-ARS, Beltsville, Maryland), Dan Kugler (Processing Engineering Technology, USDA-CSREES, Washington D.C.), Robert Myers, (Jefferson Institute, Columbia, Missouri), Robert Armstrong (USDA-AARC, Washington, DC)

The panel discussion will address policy barriers to new crops and new uses development, opportunities to overcome the barriers and Federal legislation relevant to these issues. Funding programs within the Departments of Commerce, Energy, and Agriculture offer competitive awards that support basic, applied, and developmental research, with an emphasis on product development and commercialization.

The Department of Commerce Advanced Technology Program provides funding to industry for high risk, high payoff R&D on emerging technologies.

The Department of Energy solicits proposals for the Regional Biomass Energy Program, Small Business Innovative Research, the Inventions and Innovations Program, and funds are available from state energy offices.

Within the Department of Agriculture, the Cooperative State Research Education Extension Service supports the National Research Initiative and the Small Business Innovative Research program. Funding is also provided directly to land grant colleges and universities.

The Alternative Agricultural Research and Commercialization Corporation is a venture capital entity within USDA. New/ minor crops research conducted by the Agricultural Research Service will also be discussed.

FARMERS' CASE STUDIES

Robert L. Myers (Moderator)

Jefferson Institute, 601 W. Nifong Blvd., Ste. 5A, Columbia, MO 65203 USA

A panel of four farmers will be presenting some of their experiences with trying to grow a variety of new crops. A moderated discussion following the remarks will focus on particular barriers or challenges that the farmers have experienced, not only production issues, but also lending practices, crop insurance, or other marketing, institutional, and policy problems. Identification of such new crop barriers is essential to achieve success in commercializing new crop enterprises.

Vernon Mayer, Mayer Farms Partnership, Regent, North Dakota. Vernon and his family grow a variety of alternative crops in rotation with wheat on their 4,000 acre farm in southwestern North Dakota. The alternative crops include buckwheat, flax, safflower, and canola. They have also grown peas and mustard.

Mark Quinn, Quinn Farm and Ranch, Big Sandy, Montana. The Quinn father and son operation covers 2,700 acres in northcentral Montana. They have diversified their wheat operation with lentils, peas, and kamut, a specialty type of wheat. In addition to gaining value by growing crops organically, they process and market their own grain and other farmer' grain through their company Montana Flour and Grains.

Phillip Sanders, Sanders Farms Inc., Dalton, Nebraska. Phil and his father operate a 5,000 acre grain farm in western Nebraska, which is primarily a dryland wheat region. They rotate several crops in their wheat fallow system, including grain amaranth, dry beans, sugar beets, oats and proso millet. They have also grown foxtail millet and other alternative crops. Phil has been active in trying to develop the amaranth new crop industry.

Steve Sossaman, Sossaman Farm, Queen Creek, Arizona. Steve grows irrigated cotton (short and long staple), durum wheat, barley, corn for silage, and sorghum on his 1,200 acre farm. He has grown a variety of alternative crops for his area including black-eyed peas, sesame, corn, silage, guar, lesquerella, and proso millet.

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