Implementing Research, Education and Extension for Specialty Crops

Background

Specialty crops are defined in the Specialty Crops Competitiveness Act of 2004 (Public Law 108-465) as "fruits and vegetables, tree nuts, dried fruits and nursery crops (including floriculture)." That act established a permanent specialty crop committee on the National Agricultural Research, Extension, Education, and Economic Advisory Board (NAREEEAB) and charged the committee to prepare an annual report to counsel USDA on research, extension, and economics programs related to specialty crops. Two reports have been published to date. They can be found on the NAREEEAB web site (http://NAREEEAB.ree.usda.gov).

On January 31, 2007, USDA Secretary Johanns introduced the administration recommendations for reauthorization of the farm bill later in 2007. Included in those recommendations was a proposal to invest $100 million annually for 10 years in the Specialty Crop Research Initiative (see Appendix A). This initiative would fund both intramural and extramural research, education, and extension activities. In response to a request from USDA Under Secretary for Research, Education, and Economics Dr. Gale Buchanan, a partial list of strategies for the initiative was prepared (see Appendix B). The administration proposal to create a Specialty Crop Research Initiative has the support of a broad coalition of specialty crop industry groups. The administration proposal is being given serious consideration by the U.S. Congress in developing a new farm bill.

The process of creating a strategic research and extension plan for specialty crops commenced in early 2003, with leadership from CSREES and collaboration with other USDA agencies, land-grant partners, and industry stakeholders. Draft plans now exist for tree fruits, grapes and wine, berry crops, and vegetable crops. Other industries, such as citrus, nursery, and floriculture, have plans in various stages of development. In 2006, a consortium of industry stakeholders created the Specialty Crop Research Team (SCRT). This group recognized the commonalities that exist among the individual strategic plans and has sought to identify common goals and strategies that can have solutions in research, education, and extension programs. As part of their basic premise, the SCRT recognizes that "…research results must be delivered to, and implemented by, producers and processors via world-class extension and outreach." This sentiment was echoed by Dr. John Marburger, science advisor to President Bush, who stated, *"Getting what we know into the hands of those who need the knowledge is as great a challenge as scientific discovery and innovation."* The SCRT has created a unifying list of national research and extension needs that outline common strategic priorities in four key areas of research, extension and education:

- Understanding and Improving Quality;
- Understanding Consumer Perceptions of Specialty Crops, the Role of Nutrition in Specialty Crops, and the Economic Contribution of Specialty Crops to Rural Economies;

- Enhancing Processing and Production Efficiency; and
- Developing and Promoting Sustainable Practices.

CSREES Response

A CSREES-wide team of national program leaders developed a vision for an *integrated, research, education, and extension competitive grants program* as the first step toward implementing the extramural portion of the USDA Specialty Crop Research Initiative (hereafter referred to as the Initiative). Based on stakeholder input and previous agency initiatives, economic, environmental, and social sustainability must form the umbrella, or overarching objective, for the Initiative. The Specialty Crop Committee of NAREEEAB articulated this view in its 2006 report, "If the sector is to achieve long-run sustainability, it must be economically, environmentally, and socially sustainable." Adopting and implementing this perspective means that discipline-focused approaches alone cannot achieve effective problem solving in the identified need areas of productivity, efficiency, and profitability. Specialty crop industry problems (and their solutions) must be viewed, and treated, as systems of interrelated processes, participants, institutions, collaborations, and technologies in a comprehensive manner.

This vision of a systems-based approach (see Figure 1) consists of a hierarchical taxonomy of systems, which, in total, define a "producer-to-consumer" system. The primary specialty crop systems—crop production, processing and distribution, and consumers and markets—appear at the highest level, with specific subsystems found within each. Emphases would be placed on efforts that focus on an entire primary system or where two or more of the primary systems overlap/intersect. At the most specific level of the hierarchy, one finds traditional, disciplinary research, development, and application efforts (more narrowly focused investigations), which would also be envisioned as part of this Initiative. With sustainability as an umbrella goal for the industry, the following programmatic details rely on a hierarchical systems approach to science-based research, education, and extension.

The Initiative, as proposed by the Secretary, emphasizes problem solving that leads to measurable outcomes. We would expect to engage producers and consumers of specialty crops in various activities related this Initiative, including: define problems; develop and manage research tools to address identified problems; translate research findings into practical applications; and create teaching tools and resources to prepare the next generation of scientists and professionals. Knowledge generation, through basic, developmental, and applied research, needs to integrate with extension and education functions of technology transfer, outreach, teaching, and engagement. In this integrated framework, extension assumes the role of stakeholder for research, and research becomes a stakeholder for extension activity; while producers and consumers provide feedback to both functions.

Details

The following subsections provide more details about how this vision of the Initiative might operate. First, there are overview issues related to stakeholder interactions, joint-agency activities, and operating principles. Second, a programmatic layout depicts specifically what types of programs and emphasis areas might be contained in an eventual request for applications (RFA). [No attempt has been made here to craft an RFA-style document or to imply that the expressed ideas would necessarily translate into an RFA.] Finally, we outline several types of projects that could be supported by this Initiative and that seminally reflect this systems approach.

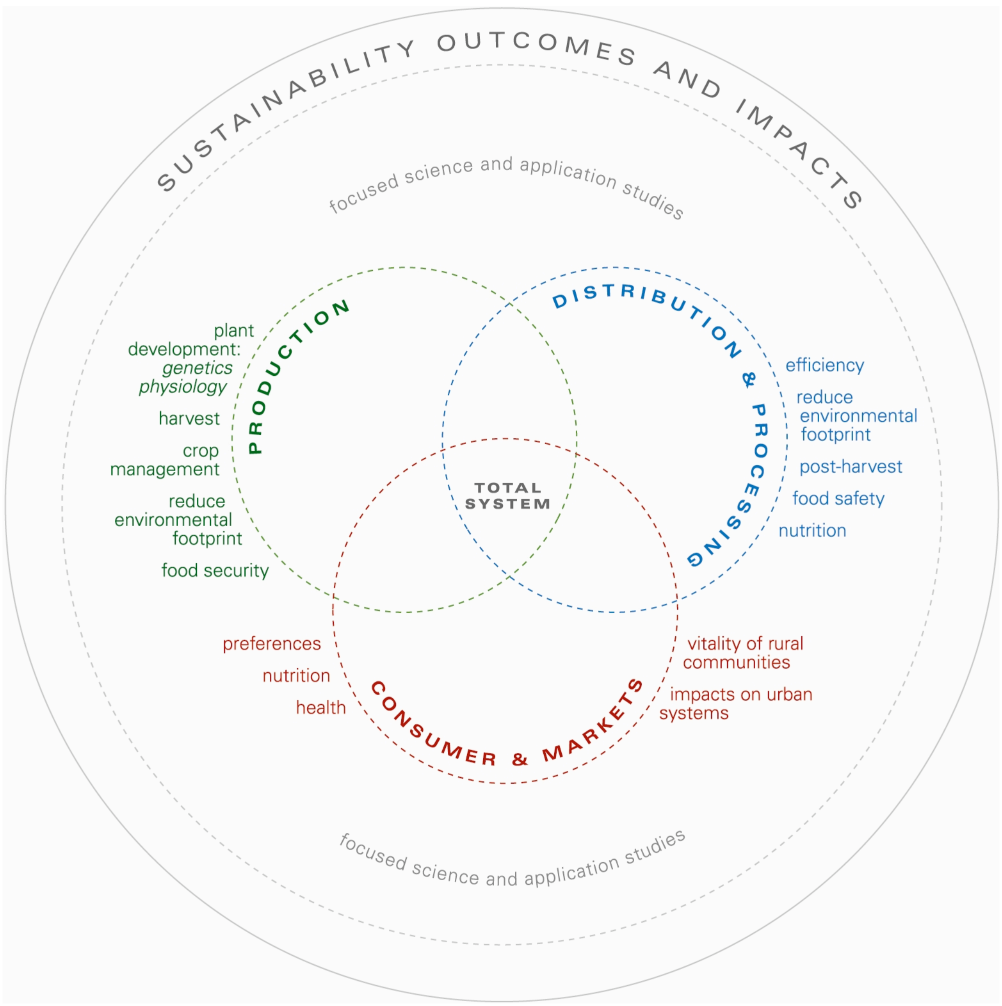

Figure 1. Under the umbrella of sustainability, this vision for the initiative contains three interacting *primary* systems: production, processing, and consumers. These three primary systems contain subsystems and focused scientific studies (several examples are listed). Except for the most narrowly focused projects, social, economic, and environmental aspects would be included in most projects.

Overview

Because this is a stakeholder-driven Initiative, we would expect to incorporate and solicit their input in several ways. First, prior to the development of any RFA, industry representatives, academic partners, state departments of agriculture, USDA agencies, and other federal agency representatives would work together to develop a 5-year strategic plan. Second, beginning in year two of any implementation of the Initiative, an annual workshop would review progress made during the previous year and re-examine the five-year strategic plan. Future RFA writing processes would incorporate changes recommended at these workshops. The workshops would bring together grant awardees, industry stakeholders, and state and federal agencies. Third, individual programs within this Initiative would seek to include industry participation on all proposal review panels.

Furthermore, given the proposed magnitude of this Initiative, the NAREEEAB Specialty Crop Committee would be provided with an external program review of the Initiative at the end of 3 years. Subsequent to that review, CSREES, in collaboration with an outside evaluator, would prepare an annual program report for the committee. These reports could be used by the committee as part of its annual reporting process as mandated in the Specialty Crops Competitiveness Act. Their response to the CSREES annual reports could be incorporated into future RFA writing processes along with the aforementioned workshop outcomes.

CSREES program staff has worked closely with various other federal agencies whose interests align with some of the Initiative's programmatic areas. Agencies include USDA's Animal and Plant Health Inspection Service, Agricultural Research Service, Economic Research Service, National Agricultural Statistics Service, Forest Service, and the Natural Resources Conservation Service, National Science Foundation, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Institute for Occupational Safety and Health, National Institutes of Health, and Environmental Protection Agency. Others, including the National Institute of Standards and Technology and USDA's Agricultural Marketing Service may eventually be included. These relationships present many opportunities to leverage Initiative funds with those of other agencies to create more effective outputs and impacts. The systems approach promoted under this implementation, with its focus on sustainability, should be compatible with the programmatic agendas of these other federal agencies.

To help ensure that projects would emphasize social, economic, *and* environmental components as appropriate, "trans-disciplinary" (defined later) specifically incorporates some combination of those three aspects of sustainability. For projects that might deal with the three primary systems or component subsystems, it would be difficult under this initiative's "systems" paradigm not to include social, economic, and environmental concerns. Regional Partnership for Innovation projects, described below, would necessarily include economic, social, and biophysical components from the start. More traditional, focused-science studies generally would have less of a sustainability aspect, given their narrower scope, but could be encouraged to do so through specific RFA language.

Program Layout

The four *hypothetical* programs identified below follow the prior delineation of primary systems, along with the inclusion of a Cross-System Program. For each program, there is a suggested proportion of resource investment. In the context of our systems view, however, it makes more sense to consider the programs and their emphasis areas organized as in Figure 2. It would be the intent of this Initiative to fund projects that complement other CSREES competitive programs (e.g., food safety, integrated pest management, organics, and other areas that already have significant agency investments). This Initiative would expressly fund systems-level projects (not generally supported elsewhere in the agency) and other studies that do not have significant agency investments (e.g., automation, biological pest controls, controlled-environment production, precision agriculture and geospatial technologies, etc.). As the graphic indicates, many emphasis areas lie at the interfaces of the three primary specialty crop systems: production, processing, and consumers. However, even though a particular emphasis area lies at the interface of one or more primary systems, it does not mean that all funded projects in that emphasis necessarily must address more than one primary system. For example, a project dealing with "product quality" could focus just on the specialty crop distribution and processing system and submit to that program area.

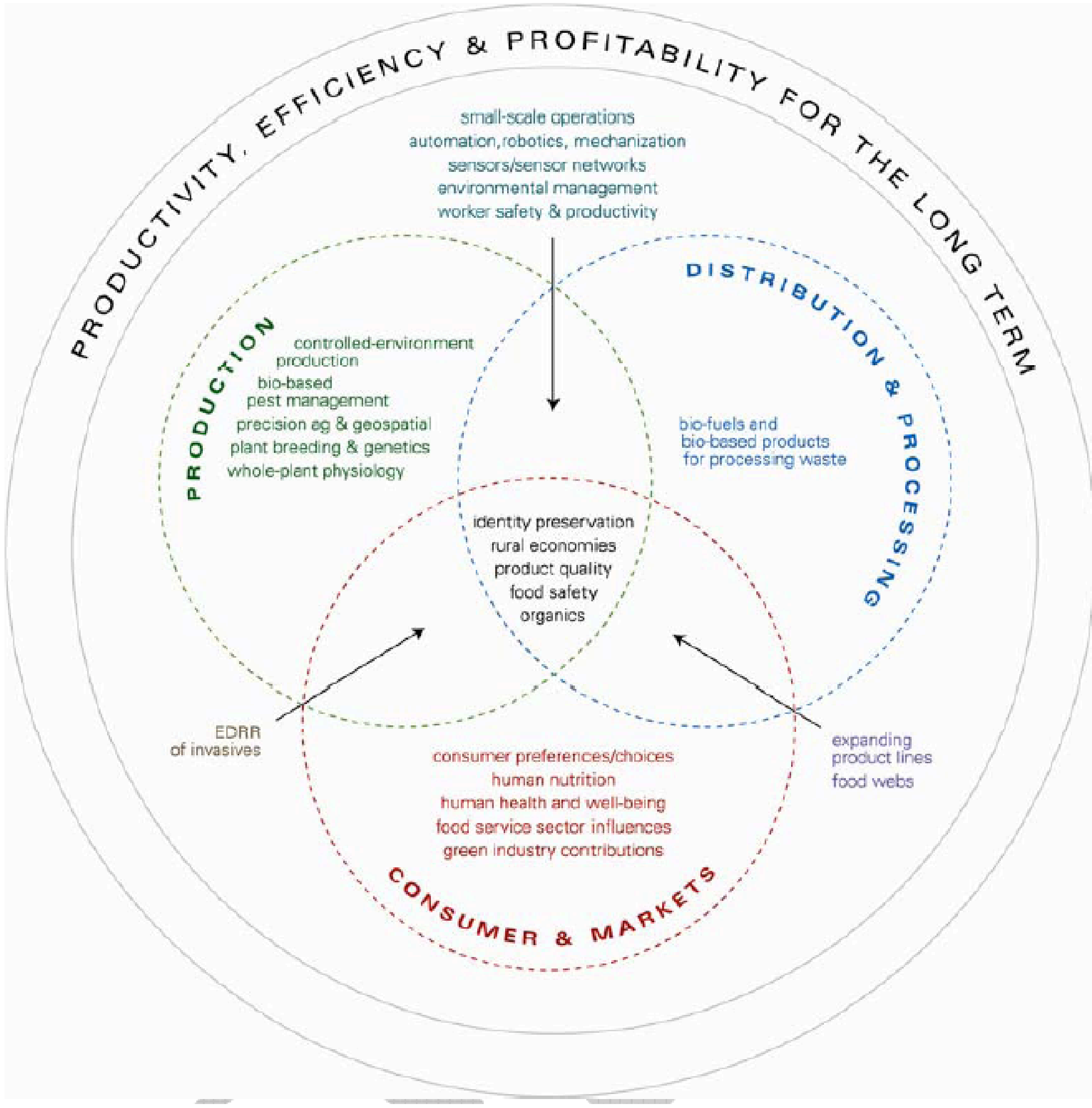

Figure 2. A graphical program layout emphasizes the system nature of this initiative and the interrelatedness of the primary specialty crop systems.

1. <u>Production System Program (about 30 percent of total effort)</u>

Production continues to be the most resource-intensive and the most variable and uncertain component of specialty crop industries. Plant material, soils, water, fertilizer, pests, cultural practices, and weather all affect the characteristics of the harvested product. Substantial productivity and production efficiency increases are crucial to industry survival. Without significant increases in profit potential, many of these producers will be forced out of business by international competition. Key components of increased efficiencies are automation and mechanization of production, handling, and processing; enhanced knowledge of pest-plant interactions and sustainable management systems; and improved worker safety and productivity. Furthermore, the industries are challenged with increased environmental regulatory pressures and a poor understanding of product quality and product safety and how to achieve it through the interaction of plant genetics and cultural practices.

2. Distribution and Processing System Program (about 20 percent of total effort)

A crop enters the distribution and processing system after it leaves the production area. On average, 25 percent of fresh market products are lost in this system. This "shrinkage" prevents handlers and distributors from offering higher prices to growers and passing savings on to consumers. In addition to discovering and implementing new handling processes, increasing consumer demand will mean that products move through the distribution system at a faster rate, which will also decrease losses. Naturally, as the raw product moves through the system, waste is generated. The industry needs to reuse and recycle this waste to help meet environmental regulations and, if possible, develop useful products from the waste stream to increase profitability.

3. Consumers and Markets System Program (about. 20 percent of total effort)

This primary system deals with people (e.g., consumers) and economic institutions (e.g., markets) within which those people act and are acted upon. While there is considerable understanding of the importance of specialty crops in the human diet (see USDA dietary recommendations), consumer behavior does not reflect this knowledge, either in food preferences or choices. A more complete picture of the health benefits of specialty crops would help create a more convincing message for consumers. We also need to understand better how marketplace factors and trends affect consumer behavior and how those factors can influence consumer choices in healthy ways. Furthermore, the food service sector influences, through marketing, promotion, and presentation, how consumers view and respond to specialty crop product offerings. There is a need to both educate those industries and to understand better those subtle influences on consumer behavior. And finally, producers and processors must understand consumer preferences so that products that will benefit consumer health and well-being are produced and marketed in ways that lead consumers to choose those products.

Specialty crops play a role in human well-being beyond that derived from food products. Specialty crop production facilities offer ecosystem services that help preserve natural resources and contribute to the vitality of rural communities. These services need to be understood and documented and ways to improve that contribution need to be elucidated. Non-food specialty crops account for a significant portion of the farm-gate value of the sector. These crops contribute to societal health by providing consumers with aesthetically pleasing living conditions and by contributing to over-all human health. For example, 83 percent of all U.S. households participated in one or more types of do-it-yourself indoor and outdoor lawn and garden activities in 2005. Research, education, and extension to support this component of the sector are essential. Furthermore, the contribution of consumer involvement in such activities toward over-all health (such as obesity prevention and reduction) needs to be understood and subsequently promoted through education and extension programs.

4. Cross-System Program (about 30 percent of total effort)

   Projects in this program would focus on efforts that cut across two or more of the primary system areas above. Many of the problems associated with productivity, efficiency, and profitability are "producer-to-consumer" in nature. To solve industry needs for the long-term, it is critical to treat "food safety," "organics production," or "product quality" within the full context that cuts across these primary systems. In other cases, this program area could support cross-cutting projects that bridge only two of the primary systems. We would expect that many of the truly lasting impacts of this Initiative will accrue through work performed at these interfaces between primary systems.

Project Types

The following six project types might be appropriate for this vision of the Initiative and would help support the system-based approach described above. *For maximum flexibility and effectiveness, each of the four programs above could fund projects within any, or all, of the project types listed below.*

1. **Coordinated Systems Projects** (CSPs) are envisioned as awards to consortia of qualified applicants who take a whole-systems approach to address issues for which there is the promise of some relatively short-term progress toward solutions. The intent would not be to provide long-term funds for ongoing centers, but rather to facilitate specific issue-focused, integrated collaborations. In addressing an identified issue, it is expected that a CSPs would deal with one of the primary systems in total (e.g., distribution and processing system) or work across two or more of those primary systems. Funded projects would apply trans-disciplinary[1], multi-functional[2], and, where appropriate and necessary, multi-institutional approaches to provide viable solutions to the highest priority stakeholder needs. CSPs might initiate Centers of Excellence to address issues for which immediate solutions are possible, while encouraging long-term collaborations that could then be self-supporting. A CSP might last 3–5 years and be awarded $3 million to $10 million. An example of a CSP appears in Appendix C.
2. **Coordinated Agricultural Projects** (CAPs), while similar in some respects to CSPs, would generally be smaller in scope and of non-continuing duration. CAPs could be awarded to consortia or groups of qualified applicants to address specific components of a primary system, with the expectation that the project will make strong contributions to the sustainability of the system of which the component is a part. These projects would apply trans-disciplinary[1], multi-functional[2], and, where appropriate and necessary, multi-institutional approaches to provide viable solutions to the highest priority stakeholder needs. A CAP might last 3–5 years and be awarded $1 million to $4 million. A CAP example appears in Appendix C.

[1] Defined here as some combination of bio-physical, economic, and social science disciplines.

[2] Multi-functional refers to a combination of extension, higher education and basic and applied research.

3. **Regional Partnerships for Innovation** (RPI). As new technologies spin off from this Initiative, there will be a need to help those products reach commercialization so that they become available for adoption by industry. The federal Small Business Innovation Research programs help individual small businesses develop and prototype pre-commercial products and services. However, organizational and networking resources are needed for "support networks" that encourage regional economic development. These networks would be comprised of collaboratories or partnerships among universities, local governments, financial stakeholders, end-user industries, manufacturers, community organizations, etc. Project grants would support initial development of regional partnerships with the expectation that they would be self-supporting by grant termination. An RPI might last 2–3 years and be awarded $1 million to $1.5 million. An example RPI project appears in Appendix C.
4. **Educational Cluster Projects** (ECPs) would be used to help stimulate individuals to develop careers in areas of need for the specialty crop industries. Project funds would support recruitment, curricula development, and innovative educational experiences for new cohorts of students who will become professionals in the specialty crop industries and related support and technology sectors. ECPs would emphasize projects that cross disciplinary boundaries and incorporate economic, social, and environmental exposure in a way that integrates those different perspectives. These projects could address both formal and non-formal programs of K-12, undergraduate, and graduate training, with emphasis on developing undergraduate programs that offer students a research experience and on creating stimulating and challenging K-12 science programs. An ECP might last 4 years with a maximum award of $1 million.
5. **Standard Integrated Projects** (SIPs) would support targeted problem-solving efforts that would not otherwise qualify in scope for support under CSPs or CAPs. Beginning with stakeholder-identified concerns, projects would seek solutions that involve a combination of research, education, and extension and that lead to measurable benefit to producers and consumers. These grants would be used to provide support for projects that do not otherwise have an obvious competitive funding mechanism elsewhere in the agency; that address more narrowly focused science or application needs; or that contribute to the overall sustainability of a component or primary system. A SIP award would be for up to 4 years and in the range of $500,000 to $1 million.
6. **eXtension Projects.** Groups of qualified individuals could receive grants to develop Communities of Practice (COP) proposals for the eXtension system. Follow-on grants would provide additional resources to insure that information and technology transfer reaches adopters as quickly as possible. Awards for grants would have a maximum of $100,000.

Appendix A

SPECIALTY CROP RESEARCH INITIATIVE

A RECOMMENDATION BY USDA FOR THE

2007 FARM BILL

Recommendation In Brief

Invest $1 billion over ten years to establish a Specialty Crop Research Initiative to provide science-based tools for the specialty crop industry.

Problem

Enhanced research, extension, and education programs are needed to help the specialty crop industry address these challenges. The USDA's National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB) recently recognized this need in their report on specialty crops.

During the Farm Bill Forums, many specialty crop producers spoke about the inequities in the current system and the need for greater investment in research. For example, Charles, from Georgia, noted that "federal investment in agricultural research dedicated to the economic vitality and long-term viability of United States specialty crops has been extremely limited….Federal investments in research for specialty crop production, processing, marketing and consumption which influence public access to these vital commodities must be re-emphasized in the next farm bill."

And Tom, at the California forum, stated: "Specialty crops are vital to the health and well-being of all Americans, and increased consumption of specialty crops will provide tremendous health and economic benefits to both consumers and growers….The next farm bill must address specialty crop issues much more effectively than in the past farm bills….Policy areas that the next farm bill must address, with respect to the unique needs of specialty crop growers, include the following: specialty crop block grants, international trade, nutrition, marketing, invasive pest and disease issues, research, competitive grants, and conservation programs."

Recommended Solution

The Administration proposes investing $100 million in annual mandatory spending to create a new Specialty Crop Research Initiative to address the critical needs of the specialty crop industry. The initiative will support both intramural and extramural programs across the nation and provide science-based tools to address needs of specific crops and regions. Focus areas will include:

1. Conducting fundamental work in plant breeding, genetics, and genomics to

improve crop characteristics such as product appearance, environmental responses and tolerances, nutrient management, pest and disease management, enhanced phytonutrient content, as well as safety, quality, yield, taste, and shelf life.
2. Continuing efforts to identify threats from invasive species such as Citrus Greening and Glassy-Winged Sharpshooter.

3. Optimizing production by developing more technologically efficient and effective application of water, nutrients, and pesticides to reduce energy use and improve production efficiency.
4. Developing new innovations and technology to enhance mechanization thus reducing reliance on labor.
5. Improving production efficiency, productivity, and profitability over the long term.

Background

The U.S. specialty crop industry is comprised of producers and handlers of fruits, tree nuts, vegetables, melons, potatoes, and nursery crops, including floriculture. It is a major contributor to the U.S. agricultural economy. Specialty crops accounted for 10 million harvested cropland acres in 2004. The value of total U.S. specialty crops ($49 billion in sales) now exceeds the combined value of the five major program crops ($45.8 billion in sales).

One of the principle opportunities to enable the specialty crop industry to remain competitive in the global environment and to continue contributing to the U.S. economy is to support research programs that facilitate continued advancements in productivity and technology.

Appendix B

A partial list of priorities based on the USDA Specialty Crop Research Initiative focus areas

Based on stakeholder input, USDA has identified a number of priorities within each of the five focus areas.

Conduct fundamental work in plant breeding, genetics, and genomics to improve crop characteristics, such as product appearance, environmental responses and tolerances, nutrient management, pest and disease management, enhanced phytonutrient content, safety, quality, yield, taste, and shelf life.

1. Enhance the USDA/ARS National Plant Germplasm System in order to provide plant breeders and geneticists with the raw materials needed to produce improved plant cultivars.
2. Fund and conduct research to describe the genomes of important families of specialty crop plants.
3. Fund and conduct research to understand how identified genes modify plant response to biotic (insects, diseases, weeds) and abiotic (water, nutrients, air quality) factors.
4. Fund and conduct research that leads to the development of new plant cultivars that are more resistant to all plant pests and more tolerant of unfavorable environmental factors.
5. Fund and conduct research to determine the regional suitability of newly developed cultivars.
6. Develop and maintain Internet-based registries and databases of genetic resources (e.g., the USDA/ARS National Germplasm Information Network System), which are available for important specialty crops.

Continue efforts to identify threats from invasive species such as Citrus Greening and glassy-winged sharpshooter.

1. Develop the National Clean Plant Network to provide growers with plants that have been tested for insects and diseases in order to prevent the spread of invasive species through asexual propagation.
2. Develop systems to identify, detect, prevent the movement of, and control new, potentially harmful imported pests.
3. Develop automated systems to detect harmful pests in production fields to limit their spread to other, non-infested fields.
4. Develop new control strategies for established and emerging insect and disease threats—such as white rot of onion and garlic, rapid vine decline of watermelon, and citrus canker—that combine enhanced detection and identification technologies with improved integrated pest management strategies to optimize the

efficacy of cultural, biological, genetic, and chemical control methods and also maintain or enhance environmental quality.

5. Fund and conduct research to develop biologically based pest management strategies that are effective, economically feasible, and sustainable.

Optimize production by developing more technologically efficient and effective application of water, nutrients, and pesticides to reduce energy use and improve production efficiency.

1. Develop and aid in the implementation of best management practices and efficient application technologies that reduce the total amount of, and target timing and application of, nutrients, chemicals, and water needed to produce optimal specialty crop yield.
2. Develop improved conventional crop production systems that reduce input costs while meeting consumer demand and maintaining or enhancing profitability and environmental protection.
3. Create the necessary extension and outreach capacity to implement current best practices and apply new technologies and develop innovative strategies to control and optimize specialty crop production, handling, and processing.
4. Reduce nitrate use, pesticide use, and runoff/leaching from production fields to prevent contamination of soil, air, and water.
5. Develop improved management technologies to reduce waste streams, re-use waste products within the agricultural production systems, or convert waste products into profitable consumer and industrial products.
6. Develop enhanced irrigation strategies for specialty crops.
7. Develop alternative production systems, including controlled environment systems, such as greenhouses and high tunnels.

Develop innovations and technology to enhance mechanization, thus reducing reliance on labor.

1. Improve mechanization technologies to reduce labor and energy requirements, improve efficiency and efficacy of pest management, and improve worker safety.
2. Develop plant production systems in the field that complement automation and mechanization of cultivation, handling, and processing.
3. Optimize production, processing, and handling by means of automation and application of new equipment, sensors, instrumentation, and procedures.
4. Develop and optimize technology platforms for measuring and assessing quality-related attributes of specialty crops.

Improve production efficiency, productivity, and profitability over the long term.

1. Develop market-driven production strategies to satisfy urban population center demand for regionally produced specialty crops and diversify food supply chains for increased national food security.

2. Develop whole-system biologically-based management strategies for weed, insect, and disease control using preventative practices as first defense and therapeutic controls as rescue practices.
3. Characterize consumer perceptions of specialty crops.
4. Quantify economic and social benefits of specialty crop industries to local communities.
5. Understand the role of specialty crops in human nutrition and health.
6. Enhance the quality (including taste and appearance) and shelf life of fresh fruits and vegetables, which will boost consumer demand, broaden the market range, and increase profitability.
7. Enhance food safety of specialty crops through improved detection and identification technologies, and improved production, and processing practices.
8. Develop superior technologies for post-harvest handling of products, and for managing post-harvest pests and pathogens.
9. Develop new products and new uses of specialty crops, including both new food uses and new non-food uses.

Appendix C

Examples of Projects

Coordinated Systems Project

Fresh market fruits and vegetables are easily damaged and highly perishable. Traditionally, these products have been harvested by hand. The cost and availability of manual labor for the harvest process is a severe impediment to the long-term sustainability of the U.S. fresh market produce industry. One solution is the development of automated harvesting systems. However, even this simple-sounding solution cannot be achieved without major changes to the entire production system. A good example is the modern apple industry.

The cultural production system for apples has evolved over the millennia based on the use of manual labor. Planting schemes, plant architecture, cultural management, and virtually every aspect of producing the crop has been developed based on the assumption that manual labor will be used for operations such as pruning, pest management, and harvesting. In order for automation to be successful for this industry, whole system modifications are essential. New training systems that make the fruit more accessible to machinery are needed. Those training systems might not be attainable without dramatic genetic modifications. While cultural systems are modified to accommodate automation, basic functions, such as crop nutrition, pest management, and crop quality, cannot be sacrificed. Machinery developed for harvesting has to be adaptable to multiple uses, such as pruning, spraying, and monitoring, to justify the cost of purchase. These issues cannot be solved in a piecemeal fashion. Rather, the solutions must come simultaneously in order to be useful to growers.

Automated harvest systems are most efficient when all fruit can be harvested at the same time. Genetic modifications are needed to insure that this occurs. A combination of genetic modification and physiological manipulation can ensure that the majority of the fruit fall within a specific grade size. This would also facilitate the sorting, packing, distribution, and marketing chain. Apple sizes could be targeted to specific consumer preferences. For example, for school lunch programs, smaller apples are favored because children will consume the whole fruit, which eliminates waste and clean up. Under current production systems, smaller fruit tends to be less ripe and, therefore, children often shun fruit that is provided in school lunch programs. As adults, these children are less likely to choose apples based on the experiences of their youth.

Only 10 percent of the flowers produced by an apple tree in a single year are needed to produce a full, commercially acceptable yield. While producing cultivars that are amenable to automated harvest, it may be possible to manipulate the genome to develop trees that produce fewer flowers which bloom in a more concentrated period of time. This would eliminate the need to thin blossoms and/or fruit, which is often done with chemical thinners. A more concentrated fruit set period would result in more uniformly sized apples that would ripen at about the same time. By managing the number of apples that mature on the tree, apple size can be determined.

Studies show that equipment operators receive more pay than manual laborers. Higher wages and jobs that last throughout the year eliminate the need for equipment operators to move from region to region in search of work. This stability allows them to establish residency, which makes them eligible for other benefits, such as in-state tuition at colleges. Stable populations also benefit rural communities because the money earned stays within the community, rather than moving with a migrant population. The development of automated harvesting and production systems will have social impacts that need to be defined and optimized.

Coordinated Agricultural Project

In the above apple example, it is probable that part of the solution will involve genetic manipulation of the crop plant. However, apples are a long-lived perennial crop that can take as long as 6 years to bear a full crop. Tree fruit breeding programs can take as long as 15 years to produce a single cultivar that is suitable for the marketplace. Based on information that has been developed in the NRI genomics program, it should be possible to shorten the juvenile period and/or develop screening systems that will allow breeders to decide whether a particular clone has suitable characteristics in a much shorter period.

Regional Partnerships for Innovation

Many regions of the country are looking toward technology industries as engines of economic development. At the same time, state universities and land-grant colleges have already established a base of knowledge and expertise in the agricultural, food, and environmental sciences. Many of these institutions also have significant capacities in physics, mathematics, computer and information sciences, and engineering. Because of the inherently high value of many specialty crops, constant monitoring of plant condition and rapid response to water, nutrient, and pest infestations is crucial to productivity and profitability. So, for example, research and development into high-density sensor networks for monitoring and detection of plant condition, as well as many other similar innovations, could have dramatic long-term impacts for the specialty crop interests within a region. Not only is the road from research to development to commercialization to adoption a long one, it is also fraught with many pitfalls unrelated to any specific technology. These hindrances can be financial, workforce, legal, regulatory, infrastructure, etc. Regional support systems, established to mitigate or minimize many of these roadblocks to innovation, could be a big boost to rural economic development. A technology partnership could serve as a specialty crop support network to help ensure that such innovations will find a home within the region to anchor, be nurtured, and grow. This support consists of business and legal services for start-up businesses (including intellectual property issues), capital funding sources for new ventures, commercialization support for new technologies, a well-prepared workforce to support the innovations, and a well-educated community that will welcome the businesses producing the innovations.

This partnership would also garner local government support and would have developed a business plan to maintain the partnership beyond the term of the grant.