APPENDIX 7. Report of the CSREES Review Team investigative meeting, June 30-July 2, 2004.

United States Department of Agriculture

Cooperative State Research, Education and Extension Service

Washington, DC 20250-2220

Date: July 30, 2004

To: S.A. Slack, OH
C.Y Hu, OR
S. E. Reiling, ME
R.I. Westerman, OK

From: A. M. Thro, CSREES, USDA

Re: CSREES review of NRSP-6, Inter Regional Potato Introduction Project

Copies: Review Team members
R. Otto, CSREES, PAS
PAS Plant Section Leader
J. Bamberg, NRPS-6
Dean Elton Aberle, WAES Director, Ag Hall, 1450 Linden Dr., Madison, WI 53706
Gretel Dentine, WAES Research Director

Dear Dr. Slack:

Enclosed please find documents from the CSREES review of NRSP-6, June 28-July 2, 2004. The Review Team of potato germplasm experts and users was appointed in September 2003 in anticipation of a scientific review of NRSP-6. We note the letter of June 4, 2004, from the ESCOP NRSP Review Committee, to you as lead Administrative Advisor to NRSP-6, and forwarded to the review team on June 14. Based on this letter, the Review Team recognizes that there are additional issues to be addressed.

We are submitting two documents. The Review Report is a scientific review. Team members are listed on Page 1 of this Report. Along with the Scientific Review Report, we submit a 3.5-page Supplement which addresses the additional issues raised by the letter of June 4. (Note that both documents are distinct from the renewal proposal that is being prepared by NRSP-6 project leadership). The discussion in the Supplement is a result of interactions between the Review Team, the Administrative Advisors, and NRSP-6 leadership. We hope it that it will be of value to you and your colleagues as you continue your roles as advisors to this important germplasm program.

The Review Team recognizes that the alliance of ARS and CSREES in the National Plant Germplasm System, and in NRSP-6 activities in particular, produces value for scientists, educators, farmers and consumers. We believe the alliance should continue through joint funding from both CSREES and ARS. Even should the functional loss be covered by funds from other sources, the value of the ESCOP-CSREES/ARS collaboration now embodied in NRSP-6 would be largely lost if all NRSP funds are re-directed out of NRSP-6. The Review Team further encourages ESCOP to consider its wishes for engagement with the National Plant Germplasm System over the long run.

We thank the staff of NRSP-6 and members of the NRPS-6 Technical Advisory Committee for their collaboration. We hope that this review will be useful to NRSP-6 and its administrators, to the ESCOP NRSP Review Committee, and ultimately to the stakeholders of the state/federal partnership.

I will be happy to respond to any questions you may have.

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Attachment: ESCOP NRSP Review Committee letter, June 14, 2004, to S. Slack *et al.*

EXPERIMENT STATION COMMITTEE ON ORGANIZATION AND POLICY
NRSP Review Committee

Date: June 4, 2004

To: S. A. Slack, OH
C. Y. Hu, OR
S. D. Reiling, ME
R. L. Westerman, OK

Re: NRSP Review Committee Preliminary Recommendations for NRSP6

The NRSP Review Committee has met to develop preliminary recommendations on actions pertaining to each of the NRSPs. The preliminary recommendations for your NRSP are presented in the following paragraph. In terms of the process for eventually getting recommendations to the Experiment Station directors at their fall meeting, the next step is to allow you to make any rebuttals or response to the preliminary recommendations. Those responses, in turn, will be sent to the Executive Directors for the four Regional Associations so that the Associations can have one more opportunity to review the information on your NRSP at their summer meetings or other venues. Following receipt of those comments, the NRSP Review Committee will formulate its final recommendations for the Directors in August and distribute those recommendations to the Directors. You will receive a copy of the final recommendations. Therefore the timetable for events is:

By June 10	Return preliminary recommendations from the NRSP Review Committee to the NRSP Admin Advisors
By June 25:	Receive any response from the NRSP
By June 30:	Forward preliminary recommendations and responses to the Executive Directors for Regional Association consideration
By July 30:	Receive final comments from the Regional Associations on the preliminary recommendations
By August 28:	Forward final recommendations from the NRSP Review Committee to the Directors
Sept 27:	Final decisions on NRSP actions by the Directors at the ESS meeting in Oklahoma City
Sept 30:	Notification to Aas and CSREES of final actions

NRSP Review Committee Recommendation:

NRSP6 has presented an excellent justification statement in which it pinpoints the significance and importance of the potato as a vegetable crop in the US. While the case has been made for genetic improvement and preservation of potato germplasm, there is nothing compelling about this project that makes it unique. In other words, this case could be made for any other food crops. Within the project itself, the expected outcomes and impacts are not clearly delineated. Also, are there other funding options (i.e. could funding be provided with regional off-the-top funding for those regions in which potato production is significant?)? If NRSP6 chooses to apply for renewal, the case must be made as to why this project meets the NRSP criteria for off-the-top funding. Could this food crop be treated similarly to other food crops that require certified service? If NRSP 6 decides to submit for renewal, the NRSP Review Committee reminds them that off-the-top Hatch support through NRSP funding mechanisms is intended to be start-up funds and that there needs to be a clear plan in the proposal for scaling back financial support through the five year business plan. The Review Committee recommends that the committee maintain a working relationship with ARS. Finally, the Review Committee recommends funding for next year at the FY04 level of $160,525.

Should you have any questions concerning your NRSP, please contact Daryl Lund (dlund@cals.wisc.edu), Executive Vice Chair, or Gary Lemme (lemme@msu.edu), Chair.

SUPPLEMENT

to the Scientific Review Report

National Research Support Project-6 (**NRSP-6)**
Inter-Regional Potato Introduction Project
Sturgeon Bay, Wisconsin, June 30-July 2, 2004

This supplement addresses issues raised by the ESCOP NRSP Review Committee in its letter of June 4, 2004, to the Administrative Advisors of NRSP-6. The supplement is a result of interactions between the Review Team, the Administrative Advisors, and NRSP-6 leadership, and is offered in the hope that it will be of value to the Project and its Advisors.

1. NRSP-6 and ESCOP/CSREES-ARS collaboration in the National Plant Germplasm System

NRSP-6 (National Research Support Project-6) was initiated as an NC Regional Project in 1947. In 1950 it became IR-1, the first Inter-Regional Project. NRSP-6 is one of five ESCOP projects in the National Plant Germplasm System (NPGS) . The others (NC-7, NE-9, S-9, W-6) are multiple-crop projects initiated in the same era. NRSP-6 is the only project in the NPGS that includes administrative advisors from all four ESCOP regions. Other projects in the national system that focus on a single crop or crop group include wheat and small grains at Aberdeen ID, soybeans and corn genetic stocks at Urbana IL, cotton at College Station TX, citrus and date at Riverside, CA, and small fruits at Corvallis, OR. Of these specialized collections, the potato collection, NRSP-6, is the only one managed in collaboration with ESCOP.

CSREES/ESCOP funding ranges from about 8% in NE-9 to 18% in NC-7 and 22% in NRPS-6. Other funding sources are ARS (about 90% of overall NPGS support) and the individual host state of each project. Much of the rationale for the configuration of ESCOP participation in the NPGS is lost historical memory. *What remains clear is that experiment station directors valued CSREES/ESCOP - ARS collaboration in planning and management for the NPGS.*

Converging political and technical factors make plant germplasm more valuable today than at any previous time. (a) NPGS is recognized as a national security asset for long-term stability of U.S. agriculture. (b) Access to sites for collection is increasingly restricted; for example, wild potato species collected by a U.S.–Peru cooperative expedition several years ago have still not been allowed to leave Peru. (c) Molecular tools are allowing unprecedented improvements in collection management and gene discovery. Current CSREES/ ESCOP funding for NRSP-6 specifically supports its capacity to use these new molecular tools.

In light of the value of ESCOP/interagency collaboration in planning, management, and use of the collections, and the value of the plant germplasm system *per se*, the timing is appropriate for ESCOP to consider its involvement in the NPGS as a whole. The Review Team recognizes that ESCOP faces real financial constraints. It is important to take a broad view now, before piecemeal dis-investment limits alternative possibilities for future ESCOP/CSREES participation in the NPGS. Should ESCOP remain engaged with the National Plant Germplasm System in future? If so, through what administrative and funding mechanisms?

2. NRSP-6 and the criteria for an NRSP

The Review Team finds that NRSP-6's activities are appropriate for an NRSP.

(i) Potatoes are a staple food throughout the United States. Because of our high potato consumption (each of us consumes about 139 lbs of potatoes a year), nutritional enhancements in potatoes, an outcome of NRSP-6 research support, will have broad beneficial impact. The devastating late blight disease is a daily threat to the crop in the U.S. Most of our harvest is protected with multiple pesticide treatments against this and other pests, making potato one of the heaviest pesticide users. Reduced pesticide use on potato, another outcome of NRSP-6 research support, will have a significant and nation-wide beneficial impact on producer cost and environmental health.

(ii) NRSP-6 collects, characterizes, maintains, and distributes germplasm of wild potato species, including many from areas now closed to collection. Wild potato relatives contain unique genes for nutritional value, pest resistance, improved processing quality, and new potato products. Wild relatives from NRSP-6 make up about 20% of the germplasm used in modern potato breeding in all regions of the U.S. These are appropriate activities and outcomes for an NRSP.

Regarding Part (A) of the ESCOP NRSP Guidelines document, NRSP-6 activities support potato research and breeding by maintaining and distributing genetic variation. NRSP-6 develops enabling methods and information for using wild species in research. NRSP-6 shares facilities with the host state to accomplish its work and the work of its stakeholder/users. Its support activities facilitate research in all four regions on a broad range of subjects including basic and applied research in genetics, plant physiology, pest management, and human nutrition and health, as documented in 824 publications during the current project cycle. Support to new product development will become increasingly important.

Regarding Part (B) of the NRSP Guidelines, potatoes are an important crop in all regions of the U.S. NRSP-6's work addresses six of the seven ESCOP Challenges, as described in Section A.1. of the Scientific Review Report. Stakeholder involvement in planning is well-organized through the NSRP-6 Technical Advisory Committee (TAC) and the national Potato Crop Germplasm Committee, described in Section B.2. Stakeholder use of NRSP-6 output is described in Section B.3. and Appendix 6 of the Scientific Review Report.

Regarding Part (C), off-the-top funds in NRSP-6 ($161,575) are linked to about 3.5 times that amount from ARS (56% of the NRSP-6 budget) and the host state (20%). NRSP-6 leverages additional funds, $1.53 million in the current project cycle, from federal and grower grants. Outcomes this cycle include wild potato accessions in use by U.S. researchers (Table 4 of the Scientific Review Report) ; new enabling technologies, described in 21 articles and abstracts (this work specifically supported by ESCOP off-the-top funds); and newly-characterized germplasm, described in 22 articles and abstracts (Appendix 8 and 9). Use of genetic resources in potato breeding is extensive and effective (Section A.2.), largely due to the impact of NRSP-6. Outreach is well-organized in NRSP-6, primarily germplasm distribution. NRSP-6 uses the Internet to inform potential users about its germplasm and associated information. NRSP-6 staff are active speakers and writers for their professional fields, grower seminars, and extension field days. NRSP-6 received popular media coverage including national news and farm magazines, newspaper, and public television.

3. What is unique about NRPS-6?

The Review Team recognizes that all five ESCOP-supported projects in the National Plant Germplasm System meet NRSP criteria for support activities that are nationally relevant, well-managed, well-linked, and productive, even though four are presently funded as multi-state projects instead of NRSPs. That said, NRSP-6 is unique in two ways.

First, most major crops, including soybeans, cotton, wheat and small grains, and some specialty crops, are conserved in single-crop projects, like potatoes in NRSP-6, and are not represented in the multiple crop collections of NC-7, NE-9, S-9, and W-6. The potato collection, through NRSP-6, is the only one of these single-crop projects that has ESCOP participation.

Second, NRSP-6 is the only "place" in the National Plant Germplasm System where representatives of all regions plan and manage the activity in collaboration with ARS. (The former national advisory board to the National Plant Germplasm System has not been re-chartered due to statutory limitations on the number of federal advisory committees, and is no longer available as a mechanism for input). NRSP-6 is unique in having a national TAC with Administrative Advisors at the Director's level from all four regions. Interactions among the current funding partners have evolved into an efficient, highly synergistic, and internally durable system that extends from germplasm preservation to cancer prevention research.

NRSP-6's first distinction may be a product of circumstances in the 1950s. The second distinction, however, points directly to the basic issue that the Review Team has highlighted: long-term ESCOP participation in the National Plant Germplasm System.

The present structure of ESCOP participation in the NPGS is not immutable. However, the Review Team notes that ESCOP involvement in the NPGS via a specific collection, such as NRSP-6, has been a highly successful model in ensuring that these collections are working collections providing value to scientists, educators, farmers, and consumers.

A strength of NRSP-6 is the positive interaction between ARS and CSREES, USDA, made possible by the project's ESCOP NRSP status and the associated leadership of four Administrative Advisors from the SAES system on the advisory committee. To leave the entire support of NRSP-6 outside of CSREES would jeopardize an exceptional example of effective state/federal and interagency collaboration. For example, loss of Hatch funding would mean the end of the national character of the TAC. The Review Team is concerned that the projected decline in, or loss of, the national-level Hatch funding contribution will seriously erode the collaborative relationship embodied by NRSP-6.

4. Funding for NRSP-6

In 2005, NRSP-6 will enter the last year of its current Hatch project cycle. The project is actively developing a renewal request for its next five-year cycle. Present funding mechanisms face Federal funding constraints and changes in philosophy regarding use of national-level, off-the-top Hatch funds through CSREES.

The Review Team notes ESCOP's recommendation that NRSP Hatch funding be start-up funds. While start-up funds may be appropriate for projects developing new enabling technologies, they are not designed to support long-term living resources such as germplasm collections. NRSP-6's excellent grants record is not an exception to this, since the grant funds are used for specific collection and characterization activities, not the core activities of the collection. Maintaining a germplasm collection and the web of collaboration necessary to understand and use the collection, requires sustained funding. The Review Team stresses that the only appropriate funding for the mission of NRSP-6 and other genetic resources programs is long-term stable funding, such as provided by Hatch funds.

A fee system for NRSP-6 germplasm, or for any germplasm in the NPGS, has consistently been avoided because charging a fee would contradict the U.S. international negotiating position. A fee system would favor the opposed position that germplasm users owe a financial return to the source of the germplasm. This would make it more difficult and costly for the U.S. to acquire germplasm from other countries in the long run. It would ultimately do most harm to developing countries, which have fewer resources than the U.S. to negotiate for germplasm from other countries.

The June 4, 2004, memo suggests that alternatives to the present national-level "off-the-top" Hatch funding mechanisms might be found within the SAES system. The Review Team is unanimous that its most important recommendation is that ESCOP find a mechanism to remain involved as a significant player in the NRSP-6 and the National Plant Germplasm System.

The Review Team is confident that the new NRSP-6 project proposal will develop a rationale for an appropriate level of funding to support its operations over the next five year cycle.

Scientific Review Report

National Research Support Project-6 (NRSP-6)
Inter-Regional Potato Introduction Project

Sturgeon Bay, Wisconsin
CSREES Review dates: June 30-July 2, 2004

Review Team members

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Contents

Scientific Review Report
June 30-July 2, 2004

National Research Support Project -6 (**NRSP-6)**
Inter-Regional Potato Introduction Project
Sturgeon Bay, Wisconsin

Executive Summary

1. National Research Support Project-6 (NRSP-6) is unique in the U.S. National Plant Germplasm System (NPGS) in having a national Technical Advisory Committee with SAES administrative advisors at the Director's level from all four regions. The NRSP resources of approximately $160,000 per year invested in NRSP-6 have leveraged their value many times over. Impact of this investment is seen in improved quality and reduced environmental and financial cost of potato production in every region of the United States. Every potato breeding program in the country, public and private, has used germplasm stocks from NRSP-6.

2. NRSP-6 addresses six of the seven ESCOP Challenges for the Future. Germplasm obtained, preserved, and distributed by NRSP-6 is an essential resource for developing new potato products and markets (Challenge 1). The NRSP-6 collection will serve U.S. agriculture well in the event of climate change (Challenge 3) and offers opportunities for significant improvement in environmental stewardship (Challenge 4). Potato germplasm has made and will make contributions to profitability and competitiveness (Challenge 5) of U.S. agriculture. The NRSP-6 collection provides unique resources for small-scale entrepreneurs and community food systems (Challenge 6). NRSP-6 holds resources for nutritional research that has potential for significant positive impact on human nutrition and health (Challenge 7), as recommended by the National Potato Promotion Board.

With the advent of new tools such as genomics for using potato germplasm; recent uncertainty about international germplasm access; national security needs; and new needs and opportunities illustrated by the ESCOP Challenges, NRSP-6 has become more valuable than at any previous time.

3. For an individual research program to access potato germplasm for crossing, without the support of NRSP-6, would require an estimated 4- to 5- year lead time, 18 months of scientist salary, 3 years of technician salary, legal fees, benefit sharing costs, and cost of international travel, as well as facilities and supplies. Instead, for the cost of an email, NRSP-6 provides public-and private-sector researchers in all regions with disease-free, documented germplasm, distributed within weeks. All U.S. potato breeding programs use NRSP-6 resources and speak highly of the materials, knowledge and service it provides.

4. Core funds for NRSP–6 are provided through a three-way partnership of CSREES USDA off-the-top NRSP Hatch Funds, appropriations to the operating budget of ARS USDA, and the University of Wisconsin-Madison. NRSP Hatch funds leverage about three times their amount from these other sources. Grants for collecting and characterization more than double this core budget. NRSP-6 is accountable through the ARS OSQR process; the CSREES AREERA process; the ESCOP NRSP Review Committee; the University of Wisconsin faculty promotion and tenure process; and WAES research station reviews. It is advised by a unique inter–regional TAC, and by

the national Potato Crop Germplasm Committee representing public- and private-sector potato germplasm users. It is a component of the National Plant Germplasm System (NPGS), with active linkages to the Genetic Resources Information Network (GRIN) and the National Center for Genetic Resources Preservation (Ft. Collins, CO). It is an active member of the Potato Association of America, and, along with the International Potato Center (CIP), was a founding member of the Association of Potato Intergenebank Collaborators. NRSP-6's international activities including germplasm distributions help to build diplomatic bridges for continued access to germplasm of potatoes and other crops in source countries.

5. Research support activities are acquisition, classification, preservation, evaluation, and distribution of potato genetic resources, and facilitation of their use by breeders. Examples of facilitation are identification of crossing barriers and successful crossing techniques. Outreach activities include distribution of germplasm; a website highly rated by users, editorship of the refereed American Journal of Potato Research, collaboration with national and state parks for education about native potato germplasm, and participation in popular research station field days. Project facilities are generally adequate; more could be done in the same facilities, with additional personnel.

6. Outcomes and Impact: Largely as the result of NRSP 6, the potato breeding community has been among the most progressive and successful in using genetic diversity of the crop to improve quality, reduce losses to pests, and increase adaptation and productivity. The already considerable use of potato germplasm in breeding use appears to be increasing as the work of NRSP 6 and its collaborators reveals significant potential benefits to come.

7. Anticipated future impact: The high cost of protecting potato fields from plant pests and diseases leaves significant room for contributions to environmental stewardship, lower costs of production, and farm sustainability using host plant resistances from NRSP-6. The popularity of potatoes means that further enhancements to the nutrition and health value of potatoes can have widespread impact. The NRSP – 6 collection is a rich source of diversity for vitamins, anti-oxidants, desirable carbohydrates, and even cancer-inhibiting compounds.

8. The Review Team's primary recommendation to NRSP-6 is that it focus on supporting high-impact, futuristic research such as new product development, supporting environmental stewardship and cost reduction research, and that NRSP-6 maintain and increase grower and processor contact. It also recommends that NRSP-6 continue to support prebreeding efforts to develop species-x-cultivated potato hybrids that facilitate access to new germplasm by breeders and geneticists; that it explore distribution of additional types of materials appropriate to the specific request (such as frozen leaf samples for DNA extraction), that it seek professional support to create an attractive popular internet homepage with links to the existing technical information; and that free distribution be continued as a support to U.S. breeding programs and to the U.S. position regarding open germplasm sharing among all countries.

Scientific Review Report
National Research Support Project-6 (**NRSP-6)**
Inter-Regional Potato Introduction Project

CSREES Review dates June 30-July 2, 2004
Sturgeon Bay, Wisconsin

A. Background

A.1. Relevance of NRSP-6 to the ESCOP Challenges

The Inter-Regional Potato Introduction Project, NRSP-6, addresses six of the seven ESCOP Challenges, either directly (Challenges 1, 3, 4, 5, and 7) or as one of several components in an integrated systems approach (Challenge 6).

ESCOP Challenge #1. Products and markets. Potato exports from the U.S. in 2003 were worth $646 million (ERS/USDA), and the global market for potato is growing. Important U.S. potato producing regions, and public potato breeding programs, are found in all four regions of the U.S. (see Appendix 1). Current uses are diverse, including fresh whole potatoes, and processing for chips and frozen and dehydrated potato products. There are many opportunities for new potato products to create new markets. Imagine potatoes with increased content of vitamins and other beneficial compounds, and specialty potatoes with novel colors, shapes, and flavors, including "snack-able" mini-tubers. The potato accessions available to U.S. breeders through NRSP-6 represent the necessary germplasm to develop such new potato products, to meet current and future needs for each sector of the U.S. potato industry, and even to create new products unthought-of today.

ESCOP Challenge #3. Climate change. As the distribution of potato agriculture in the U.S. shows (Appendix 1) , potatoes can be grown economically in a broad range of environments. Wild potato species grow in a great diversity of ecological niches. Consequently, potato agriculture can be expected to remain stable in spite of climate change, as long as breeding programs have access to the genetic diversity available in potatoes and their relatives.

ESCOP Challenge #4. Stewardship. At present, potatoes use more pesticides than most other crops. For example, the resurgent and devastating late blight disease is controlled by spraying crops at 5 to 7 day intervals at costs of $100 up to $400 per acre. The need to reduce pesticide use on potatoes is urgent. Resources to accomplish the reductions will come from NRSP 6. For example, recent variety releases from Michigan ('Jacqueline Lee') and the Western Tri-State program ('Defender'), which are resistant to late blight, as well as a cloned late blight-immunity gene, trace their origin to NRSP-6.

ESCOP Challenge #5. Profitability and competitiveness. (a) Environmentally-sound reductions in pesticide use will reduce production costs significantly. (b) Novel potato products have the potential to increase crop value, and diversify marketing opportunities for farmers. Small-scale farms are increasingly turning to certified organic systems as another way to add value, and need new varieties suitable to their production systems and customer preferences. NRSP-6 is providing the genetic resources to reduce use of pesticides and other costly inputs, and to add value to the crop.

ESCOP Challenge #6. Families and communities. (a) New forms of economic activity being explored in rural areas include community food systems (local production networks), which require a full range of crops to satisfy local needs; and organic agriculture. Both approaches require varieties adapted to specific production systems, and to climates where potatoes are not currently commercially grown. (b) Producers for local food systems will also benefit from being able to offer novel types of potatoes--more nutritious, more convenient, or just more fun--to their customers. NRSP-6 has the germplasm to support the ideas of the new community entrepreneurs.

(c) NRSP-6 participated in a science outreach project with youth of the Native American Makah Community, in collaboration with the NSF-funded Potato Genome Project (University of California at Berkeley and ARS). The project involved a traditional potato variety of the Makah community, Ozette. Genomic studies with material from NRSP-6 revealed that Ozette appears to have come from South America rather than from European settlers, suggesting that Native American use of potatoes may have extended to the Pacific Northwest.

ESCOP Challenge #7. Food safety and human health . (a) In 2003, per capita consumption of potato in the U.S. was 139 pounds (ERS). At this level of consumption, new benefits from the nutritional value of potatoes will have a widespread and significant effect. At this time, materials from NRSP-6 are being used in research conducted in Washington and Texas on tuber anthocyanins and carotenoids and their health benefits as antioxidants and anti-cancer compounds; on Vitamin C (Idaho) and Vitamin E (Michigan). The collection may also contain useful variation for the essential nutrients iron and zinc, key enzymes, and compounds in the beta-carotene pathway, additional anti-cancer compounds distinct from carotinoids and anthocyanins, and favorable carbohydrate balance for dieters. (b) In addition, the distribution of potato production in all four regions adds a measure of robustness to U.S. national food systems should long-distance transport be interrupted. Any accidental or deliberate introduction of new diseases or pests will require access to sources of resistance in order to have crops back in the field as soon as possible. For sources of enhanced or novel nutrients, wide adaptation, and resistances to new or changing diseases and pests, NRSP-6 is simply essential.

All of the above impacts of the NRSP-6 occur through links to SAES plant breeders and ARS geneticists, other science and technology disciplines, and potato producers and their markets. Among these parts of the potato value chain exists a strong network of mechanisms and venues for communication and cooperation (see section on Interrelationships, below)

A. 2. NRSP-6 supports extensive use of wild species in potato breeding

About a fifth of potato breeding research, or 19%, involves wild species from genetic resources collections. This is far more than the averages of 1.2% for cereals and 1.4 % for vegetables (Swanson, 1997). It is all the more remarkable because chromosome numbers are different between cultivated and wild potatoes, and crossing barriers exist between some species. Since its establishment, NRSP-6 has worked with geneticists to develop methods of crossing cultivated and wild potatoes to overcome these differences (Hanneman, 1999).

Named cultivars include genetic material from more than 20 wild species (Reid and Miller, 1989). Breeders believe that use of wild species in breeding programs has increased in recent years. Newer cultivars with wild germplasm include 'Eva' from Cornell and 'NorValley' and 'Dakota Pearl' from North Dakota State. Eva is 25% *Solanum tuberosum* Gp. Andigena with resistance to PVY and PVX virus; NorValley and Dakota Pearl derive their desirable processing quality from *S. tuberosum* Gp. Phureja. An estimated 10% of the genetics of the crop is derived from wild species. This is more than any other major crop (Cox et al., 1988). Potato breeding programs have been among the most successful of crop breeding communities in using genetic diversity (Goodman, 1990; Frey, 2000).

A.3. NRSP-6 addresses implications of global phytosanitation and access regimes for potato breeders.

The founders of the U.S. public potato germplasm collection, more than fifty years ago, were wiser than they knew. Today--when both new market challenges and new enabling technologies make the collection more valuable than ever--it would be extremely difficult or impossible to assemble the collection as it exists, because access to germplasm is becoming increasingly difficult. Potato germplasm is subject to not one, but three, regimes that make access difficult and costly: (1) global and U.S. phytosanitary regulations, which require lengthy quarantine for a vegetatively-propagated major crop such as potato; (2) global germplasm access regimes which designate germplasm as the property of sovereign nations and require both prior informed consent from a national authority of the source country, and costly benefit sharing; and (3) intellectual property rights, which in some situations allow lead public or private breeding programs to limit access to their materials.

Appendix 2 describes the steps and estimated costs, in time and budget lines, of using potato germplasm if the Inter Regional Potato Introduction Project (NRSP-6) did not exist. If an individual SAES breeder screened all U.S. public domain potato germplasm and failed to find genes for a needed trait, such as a novel consumer quality, they would incur the following estimated costs to get additional germplasm: About 18 months of scientist time, three years of technician time, domestic and international travel, facilities costs, legal fees, and costs of international benefit sharing. All this, plus four to five years time elapsed, before their research with the material could begin. And there is still the risk that the material they obtain will not contain what they need. In contrast, with the Inter Regional Potato Introduction Project (NRSP-6) , all these individual program investments are replaced by a single phone call or email. The germplasm arrives within weeks, in good condition, with a high likelihood of containing genes of interest, and with growing and crossing instructions included. This is an extremely high level of support and service.

A. 4. Funding for genetic resources conservation and use

Collections of genetic resources can be compared to a reference library, with a difference: The "books" are living organisms; actual physical sections of pages, multiplied from the originals, are needed to compose new books. Moreover, no one yet well understands the languages in which the books are written, though researchers are learning more nouns, and, more slowly, verbs and syntax. As a result, locating and using valuable traits requires intense concentration.

Because of these characteristics, stability is an internationally-recognized requirement for funding genetic resources preservation and use. For this reason the Global Crop Diversity Trust is an important element of the International Treaty on Plant Genetic Resources for Food and Agriculture (IT). The Trust was established by FAO and the International Plant Genetic Resources Institute (IPGRI). The Trust provides long-term support for basic conservation activities in developing countries, where funding is particularly fragile, and at the International Agricultural Research Centers. The Trust would provide limited support for basic conservation activities of developing countries and international agricultural research centers. Collaboration between genebanks from developing and developed countries is envisaged, through other funding opportunities such as grants, especially when in crops of global importance like potatoes. Activities are likely to include collaborative characterization and valorization activities involving genomics and advanced biochemical screening and inter-genebank training, all areas of NRSP-6 expertise .

In the United States, core funding for genetic resources has been based on yearly appropriations to CSREES (the Hatch Funds) and to the ARS operating budget. Individual SAES's often supplement with additional funding or in-kind contributions, depending on the site. This mix of funding types has historically provided stability, flexibility for leveraging other resources, and broad participation in managing the collections and creating value from them.

B. Overview of NRSP-6.

B.1. Organization, structure, and funding.

NRSP-6 is headquartered at the Peninsular Agricultural Research Station (PARS) of the Wisconsin Agricultural Experiment Station (WAES). It operates on a mix of funding from ARS and CSREES, USDA; from the University of Wisconsin–Madison Department of Horticulture and Agricultural Research Stations, and the WAES (Table 1). Off-the-top funding using Hatch Funds is approved by CSREES as Project No. WIS03911, "Introduction, preservation, classification, distribution, and evaluation of *Solanum* species", Multi-state Project No. NRSP-6 (National Research Support Project 6), currently approved Oct 1997 through Sept 2005. The reporting and funding relationships between NRSP-6 and donors are shown in Appendix 3. NRSP-6 also received $1.53 million in grants from other federal sources and private sources (Appendix 4).

Table 1. Recent funding mix, Interregional Potato Introduction Project				
Fiscal year	**ARS**	**Wisconsin**	**CSREES** off-the-top Hatch	
2000	$ 247,000	$ 128,000	$161,931	30 %
2002	335,000	142,000	161,575	25 %
2004	422,000 (58%)	150,000 (20%)	161,575	22 %

ARS, USDA is the major funder of the project. The proportion of total funding from off-the-top Hatch funds has decreased as other funding sources have risen slightly (Wisconsin) or significantly (ARS). Wisconsin's contribution includes additional in-kind support not represented in the dollar figure (such as shared secretarial services with PARS).

B.2. Planning, review, and accountability

NRSP-6 has extensive resources for planning, with participation from all regions and stakeholders. It is probably one of the most reviewed ag research activities in the nation, receiving scrutiny through no fewer than five mechanisms.

B.2. a. Planning

Technical Advisory Committee (TAC)

Functions of the TAC include approving the annual project progress report, preparing annual budget requests, and planning future activities. Each of the ESCOP regions sends both an administrative advisor and a technical representative to the TAC. The technical reps, including a fifth, the ARS USDA technical rep, form the voting membership. National Program Staff from both USDA donor agencies, and ARS area administration, are non-voting members of the TAC. Annual TAC meetings move from region to region to facilitate participation.

Technical Advisory Committee (TAC) membership:

Voting members, the technical representatives:
- Four SAES scientists, one from each region
- One ARS scientist

Non-voting members
- Four Administrative Advisors (AAs): one director from each region, selected by the Regional Associations of Directors; the North Central region AA serves as lead AA.
- NRSP-6 Project Leader
- ARS Midwest Area Office
- ARS National Project Leaders (NPLs) for Genetic Resources and for Root and Tuber Crops
- CSREES National Program Leader for Plant breeding/ Genetics
- Agriculture and Agrifood Canada representative

Standing-invitation participant: USDA, APHIS representative
Resource participants: NRSP-6 staff, including ARS Research Leader at Madison WI

Potato Crop Germplasm Committee (CGC)

The Potato CGC is coordinated by ARS through the National Plant Germplasm Resources Lab (NPGRS), which also coordinates CGCs for other crops. The role of the CGC is distinct from the role of the TAC in it is purely technical, not administrative. The CGC provides the broadest possible perspective over all activities related to the crop's germplasm, in order that activities are not duplicated and gaps are identified. Proposals to be forwarded to the NPGRS and ARS National Program Staff with requests for supplemental funding (but not the core project budget) must be approved by the CGC, such as proposals to characterize accessions for a particular trait of interest. In addition, all proposals for collecting new material to be added to the collection must be approved by the CGC.

Membership in the CGC is broad, including a balanced representation of SAES and ARS users of potato germplasm, plus a representative of the potato processing industry. States represented on the current CGS are Texas, Oregon, Nebraska, New York, Michigan, and Wisconsin.

Potato Association of America (PAA). The Project Leader is on the agenda of the Breeding and Genetics Section meeting of the PAA each year to report and ask for input on timely issues.

B.2.b. Review and accountability:

NRSP–6 is reviewed through:

- CSREES AREERA reviews (this review), approximately every five years, and annual reports
- ARS Office of Scientific Quality Review (OSQR) approves work plans of NRSP-6's two ARS senior scientists, with annual milestones and progress reports. OSQR organizes rigorous reviews by external panels at 5 year intervals. The first OSQR planning and review cycle for the project's senior scientists is July 2003-June 2008.
- ESCOP: NRSP Review Committee—these will be every five years
- University of Wisconsin: NRSP-6's two senior scientists have faculty appointments in the Dept. of Horticulture. When junior scientists, they benefited from the Department's faculty mentoring program. They are subject to departmental promotion and tenure procedures--both are now tenured full professors-- and submit departmental annual reports
- Peninsular Agricultural Experiment Station review. These occur every 5 to 7 years. In the last two station reviews, this Project reviewed highly favorably.

B. 3. Interrelationships with other entities

The Inter Regional Potato Germplasm Project has created a strong web of inter-relationships. Most of these relationships work both ways: they extend the benefits of the project, and they strengthen its ability to offer those benefits. These interrelationships are on-site, between states and regions/national, and international. Appendix 6 gives a list of SAES's and other entities with whom NRSP-6 has interacted during the current project.

<u>B.3.a. Host state</u>. Structural and financial interrelationships with the University of Wisconsin are detailed in Section B.1., above, and Appendix 3. Research relationships are strong with the Dept. of Horticulture, the Plant Pathology Dept, and increasingly with new partners such as the Dept. of Oncology for screening the potato collection for compounds that may inhibit cancer

<u>B.3.b. Other states and national</u>. The U.S. potato research community is unusually well linked, through three Hatch-funded multi-state research projects and one multi-state coordinating committee; through the CSREES-managed national Potato Research Special Grants, which require regional collaboration; and through the Potato Association of America (PAA). NRSP-6 is thoroughly integrated in this community through the TAC and the Potato CGC, through its PAA activities, and through collaborations with states to characterize accessions in the collection.

Table 2 shows examples of collaborative activities around the country. Overall, 824 research papers, theses, and abstracts in the period of 1998-2003 involved use of stocks and services of the Interregional Potato Introduction Project.

Table 2. Examples of contributions by NRSP-6 to activities in each region, current project cycle. Funds for contributions to collaborators are from the ARS research support budget.

Region	State	Partner	Activity	Contribution to collaborator
NE	NY	SAES	Late blight screening	$18,000
NE	Maine	Private	Small-scale seed effort (Seed Savers Exchange) – heirloom varieties and others for screening	No funds exchanged; provided germplasm, quarantine assistance, tissue culture expertise
NE	Maine	SAES	Materials for new potato breeder start-up	No funds exchanged; provided germplasm, quarantine assistance, expertise
S	Texas	SAES	Anti-oxidants screening . Findings: white potatoes (not only the colored ones) having high anti-oxidants and crossable with cultivated types.	$30,000
S	Florida	SAES	Tuber quality	No funds exchanged
S	N Carol	SAES	Tuber quality	$ 3000
W	Idaho	SAES	Glycoalkaloids, top-to-tuber ratio. High ratio is good for people, bad for bugs.	$28,000
W	Colorado, Utah, N. Mex, Ariz, Tex	SAES, state and nat'l parks	Collecting native North American potato germplasm	No funds exchanged. Prepared a brochure on native potatoes for use in park nature centers (Bamberg, 1999). Provided specimens to state herbaria.
W	Alaska	SAES	Rhizoctonia (root rot) resistance screening	$18,000
NC	Wisconsin	SAES	Tumor/cancer inhibition compounds screening	$53,000
NC	Wisconsin	SAES	Organic production	No funds exchanged
NC	Minnesota	SAES	Nitrogen efficiency	$15,000

NRSP-6 facilitates a large research effort, as is the appropriate role of a national research support project. The number of CSREES-funded potato research projects in the various regions is given in Table 3. Off-the-top Hatch funds for NRSP-6 appear in Table 3 as one Hatch project in each region. Additional potato research and development is supported by state funds, state potato grower commissions, ARS Cooperative Agreements, and other sources. NRSP-6 does not receive funding through other projects in Table 3 or other sources except as documented in Table 1 and Appendices 3 and 4.

Table 3. CSREES-funded potato research by region, as reflected in Hatch, National Research Initiative (NRI), and Special Grant projects. Source: CSREES Current Research Information System

Active projects FY 2004	Northeast	South	West	Northcentral
Hatch projects	37	17	63	31
NRI grants	2	2	6	3
Special grants (Includes the Potato Research Grants for potato breeding in each region)	6	1	10	9

NRSP-6 germplasm distributions (Table 4) are another indicator of potato research activity by region. All four regions have used germplasm from NRSP-6. The Western region is a particularly high user. The larger number of accessions distributed in the NC, compared to other regions, represents a nationally-efficient use of resources. The North Central potato research programs, especially Wisconsin, conduct many initial characterizations of the collection, which adds value to the collection for users in other regions. Typically, North Central potato programs conduct broad initial screening projects. Depending on the trait, these often serve as *de facto* preliminary trials for all regions. Breeders in other regions concentrate their distribution requests and research on smaller numbers of accessions that were outstanding in the NC screenings. It is anticipated that with increased use of host plant resistance to reduce pesticide applications, and with increased consumer interest in potatoes that deliver specific health benefits, the potato research community will utilize the inter-regional potato collection to an even greater degree.

Table 4. NRSP-6 germplasm distributions during the current project cycle, by region

	Northeast	**South**	**West**	**Northcentral**
Number of samples distributed	2377	1107	4581	32343* * See explanation in text above

The scientific community uses Interregional Potato Introduction Project stocks for research in breeding, genetics, cytogenetics, pathology, physiology, taxonomy, entomology, nematology, horticulture, biochemistry, and human nutrition. Use of NRSP–6 potato germplasm was reported in 824 publications, theses, and abstract during the current project period (full list in NRSP-6 Annual Reports or available from John Bamberg, NRSP-6 Project Leader).

NRSP-6 collaborates with ARS intramural potato research (Appendix 6), and is an integral member of the National Plant Germplasm System (NPGS). The NPGS is coordinated by ARS in locations across the U.S. (map in Appendix 10). It is funded jointly through the ARS appropriation (85 to 90% of the total, depending on the region and the year) and four regional or multi-state projects approved by the ESCOP Regional Directors and funded with Hatch funds (about 8 to 18% of the total) The four multi-state projects, NC-7, NE-9, S-9, W-6, involve collections of multiple crops. The NGPS also includes about a half-dozen single-crop collections in addition to the potato collection. Most major crops and some specialty crops are conserved in these single-crop projects. Examples are the small grains collection at Aberdeen ID, soybeans and corn genetic stocks at Urbana IL, cotton at College Station TX, citrus and date at Riverside, CA, and small fruits at Corvallis, OR. The potato collection is the only one of these single-crop projects that has ESCOP national or regional participation.

NRSP-6 potato accession data are available on-line through the NPGS Genetic Resources Information Network (GRIN); collection activities are coordinated with the Plant Exchange Office in the National Germplasm Resources Lab at ARS headquarters in Beltsville. The collection is backed up at the National Seed Storage Lab, National Center for Genetic Resources Preservation (NCGRP), Ft. Collins, CO (all are components of NPGS). GRIN is used by researchers throughout the U.S. and internationally, and is also a reference for the Plant Variety Protection Office and the U.S. Patent Office. NCGRP is a partner in conservation biology research such as development of optimum protocols for long-term seed viability of potato germplasm .

<u>B.3.c. Private sector</u>: NRSP-6 interacts directly with the private sector concerning their needs and opportunities through state potato grower associations in the Northcentral Region, through field visits in other regions, and indirectly through plant breeders in all regions. This is part of NRSP-6's effort to "keep one foot in the furrow" in order to see opportunities as they go about their basic

germplasm and evaluation work. For example, a private potato processing company breeder participating in the 2003 Tri-State (Oregon, Washington, and Idaho) Potato Breeding field tour suggested the value of screening accessions for tuber calcium content, and moving the high calcium trait into breeding lines from the different regions. High calcium content improves tuber resistance to internal defects caused by physiological disorders and handling. Presence of the high calcium trait in all U.S. breeding populations will increase efficiency of these programs by reducing the number of advanced selections that fail because of susceptibility to internal damage.

Indirect contacts with industry through state potato breeding programs are robust. Most state programs work in close contact with their state potato growers associations. In addition, a panel of potato growers participates in the CSREES-managed review of proposals submitted for Potato Research Special Grants. Feed-back into state potato breeding projects from these contacts and reviews then feeds into NRSP-6.

Private sector breeders are also users of the collection. Appendix 6 lists private entities that received germplasm during the current project period.

B.3.d. NRSP-6 is well linked internationally, through such entities as the Association of Potato Intergenebank Collaborators (APIC), of which this project is a founding member (Huaman et al., 2000), and through the networks coordinated by the International Potato Center (CIP), in Lima, Peru, which holds the international potato germplasm collection. CIP concentrates its potato germplasm collection on indigenous primitive cultivated types, while NRSP-6 tends to concentrate on wild species. The two collections are complementary. The NRSP-6 Taxonomist makes annual study and collecting trips to South American countries and collaborates with CIP for two months a year. Additional important screening work involves foreign collaborators, e.g., late blight resistance project in Toluca, Mexico (a center of diversity for the late blight fungus), and nematode resistance screening with the Russian VIR (N. I. Vavilov Research Institute) and Polish collaborators.

Countries receiving potato accessions from NRSP-6 during the current project cycle are listed in Appendix 6. Fourteen developing countries and 20 developed countries received a total of 15,000 distributions. Countries at the center of origin and diversity of potatoes, including Peru, Colombia, and Bolivia, are among those who have received significant distributions from the Inter-Regional Potato Germplasm Project.

International distribution of potato germplasm from NRSP-6 benefits the U.S. This is because the major part of the diversity of potatoes and many other crops is not indigenous to the U.S. Continued access to foreign germplasm requires reciprocity with donor nations. Uncertainties in the international genetic resources access regime have limited acquisition of new potato germplasm in the last decade. Collaborative collecting missions by NRSP-6 and national scientists are expected to resume when the new International Treaty on Genetic Resource for Food and Agriculture of June 29, 2004 is harmonized with legislation of countries having major potato genetic resource diversity.

The NRSP-6 DNA-lab specialist located at UW Madison leads international workshops in South American countries and elsewhere. Both NRSP-6 senior scientists advise international students, mostly from South America (6 Ph.D. students in the last 5 years). There are currently 4 international students. These international students, when they return to their native countries and become involved in breeding programs there, help to foster beneficial international exchange of information and germplasm. They become long-term ambassadors who can bridge diplomatic barriers.

C. Facilities and equipment

All accessions available as true seed are backed up locally in long-term storage (freezer) and 96% are also backed up at the NCGRP in Fort Collins. Facilities at PARS, where the germplasm collection is located, are adequate for research and germplasm processing and distribution, except where noted below.

There is a processing room for extracting and dehydrating seeds from collected fruits. A 20^{o} F (-6^{o} C) freezer is located in the same room for short-term storage of seeds (5,000 seeds are kept for short-term storage). A –20^{o} C freezer is used for long-term storage. Although the long-term storage freezer is new, the short-term freezer is old and needs to be upgraded.

There are two greenhouses and five screenhouses for regeneration and multiplication of existing plant material and for growing new introductions. Special areas are set aside for domestic quarantine of new arrivals to prevent introduction of any diseases into the collection (the ARS international quarantine is at Beltsville). One of the greenhouses is also used for supporting research projects (pigmentless mutant, tuber calcium, etc.). This latter greenhouse's covering is deteriorating and needs replacement. There is a laboratory for *in-vitro* propagation (tissue culture). Two growth chambers and an autoclave are located in the lab. The growth chambers and the autoclave are quite old and the chambers are used close to capacity. If new chambers are to be purchased, the review team recommends models with higher light intensity (1,000 to 1,500 lux), as some of the plant material appeared to be etiolated. The distilled water system could also be upgraded to a deionization unit. The lab is also set up to do DNA work including PCR. The lab does not have (or want) the capacity to handle radioactivity. NRSP-6 molecular work is carried out in the UW Department of Horticulture.

The project's vehicle, a 1985 Dodge pickup, is too old to travel far from the station. However, PARS shares vehicles with NRSP-6 for travel to the Madison campus and other sites as needed.

The Project herbarium (international herbarium code: PTIS) houses 14,666 specimens of section *Petota* of the genus *Solanum* (tuber-bearing *Solanum* species). Herbarium cases are used to capacity. Two of the cases are used for storing unmounted specimens. Herbarium specimens are shipped for use at Madison or other sites as needed. About 368 specimens were distributed during the project term, including to herbaria in states where U.S. potato germplasm was collected. There is sufficient field space for planting out seeds for identification purposes.

The station has the capacity to carry out characterization research on tuber calcium, plant hormone mutants, frost tolerance, and seed germination/viability. A significant part of characterization work, however, is carried out with collaborators elsewhere (e.g., late blight in New York state, and in Mexico (the Mexican site is a global hot spot for the late blight and therefore a valuable selection site), glycoalkaloids in Idaho and Beltsville, tuber quality in North Carolina and Florida, and antioxidants in Texas, and does not require facilities at the station. Screening for a particular trait at a collaborating site not only provides valuable data for that collaborator but also in effect extends the facilities and resources available.

Databases. The Project database specialist serves on the national GRIN advisory committee, providing feedback from a working collection and suggesting continued improvements in data management. Every accession in the potato collection is represented in a database housed at PARS and uploaded into GRIN as new data is entered. dBASE is currently used, but "migration" to Access is in progress. Access is also used for generating reports. The local database contains passport (collection) data, inventory, evaluation data, and records of germplasm requests and distribution. Databases are backed up weekly on CD disks and stored in a vault. The computer equipment appears to be adequate.

D. Activities and accomplishments

D. 1. Research Support

Potato Germplasm acquisition.: During the current project cycle, NRSP-6 collected *Solanum* species in Peru, Honduras, Panama. More recently, collecting activities have been limited to the United States (see below). In one instance, NRSP-6 provided RAPD analysis of Ram's Horn orchid populations for The Nature Conservancy, which opened doors for collecting native *Solanum jamesii* on Nature Conservancy land in Ramsay Canyon, Arizona. An additional 595 accessions were acquired from other potato genebanks and research programs. NRSP-6 also published comprehensive reviews of potato collecting and associated issues (Bamberg et al., 1997; Bamberg et al, 2003; Spooner et al., 2004). Future: After a hiatus due to international germplasm negotiations, resumption of potato germplasm collecting in species-rich Peru is pending for 2005 or 2006. This and other collecting trips are imperative due to continued habitat degradation as well as the loss of older, experienced taxonomists who can lead collection trips to known populations of wild species.

Classification: NRSP-6 potato systematics research used both molecular and classical techniques (see Appendix 7). This research is important to ensure the most effective use of germplasm by breeders and geneticists. Future: Research is planned to assess whether taxonomical classification is useful in predicting what species have useful genetic resistances, based on relatedness to previously characterized species.

Preservation: The current collection has over 5,600 accessions, of which 92% is distributable, i.e. adequate good-quality seed are on hand for distribution. The collection has 4600 active populations requiring 150-200 seedlot increases annually to maintain viable and adequate numbers of seeds for distribution. An additional 900 to 1000 clonal stocks (the number is dynamic) also are maintained *in vitro*. The NRSP-6 Germplasm Management Technology Specialist (Appendix 5) has effectively used molecular technologies to answer genetic diversity management questions regarding accession redundancies, and the potential loss of genetic diversity in genebanks using current seed increase methods (Appendix 8). The results are being used to increase genebank management efficiency and effectiveness. Future: Additional germplasm acquisitions will add to the collection, requiring identification, development, and incorporation of procedures to increase efficiency of seed production and subsequent maintenance, while maximizing genetic diversity. Apomixis (the production of botanical seed whose embryos have the identical genetic constitution of the plant derived from) will also be further characterized and developed to be used as a tool in effectively maintaining genetic diversity among collection accessions.

Evaluation (Characterization):

Germplasm, to be useful to breeders, geneticists, and molecular biologists, requires an evaluation for desirable disease resistances or quality enhancement traits (e.g., enhanced nutritional attributes, reduced sugars during long-term storage). NRSP-6 staff know the germplasm. This and their contacts with breeders and industry allow them to predict traits previously unknown and screen for them (examples: cold hardiness (Palta et al, 1998); anti-cancer compounds with UM-Madison Oncology Dept (new)). NRSP-6 conducts preliminary characterization of the genetics and physiology of traits and offers the germplasm and preliminary data to other specialists for further research and/or breeding. Evaluations conducted and reported to the scientific community by this project are reported in Appendix 9. Evaluations conducted at collaborating sites are highlighted in Part B of the same Appendix.

Future: Evaluation of the collection for traits with direct consumer impact, i.e., nutritional, anti-oxidant and anti-cancer factors, are ongoing, with additional studies planned. In addition, evaluation data (both published and unpublished) will be obtained, as currently, from researchers working with germplasm obtained from NRSP-6. Evaluation results are published and all evaluation data are entered in GRIN, allowing effective access by any interested researchers.

Distribution: During the current project cycle, NRSP-6 has distributed 44,475 seed packets, 8,443 *in vitro* plantlets, 3,766 tuber families, and 368 herbarium specimens. Recipients of germplasm represented 291 cooperators from 36 states and 35 countries**.** Future: NRSP-6 plans to explore the possibility of making DNA and pollen samples available for distribution. Germplasm DNA would be of immediate use to molecular biologists for their genetic research.

Facilitation of Use by Breeders: NRSP-6 personnel conduct supporting research to facilitate the use of germplasm by breeders and geneticists. Areas of supporting research include identification of crossing barriers and the formulation of means to overcome them, seed germination studies, identification of unique genetic mutants in species, and topics regarding reproductive biology (Bamberg and del Rio, 2004; and, Appendix 8). **Current off-the-top CSREES/ESCOP Hatch dollars specifically fund the capacity to use molecular tools in this supporting research (Table 5, Germplasm Management Technology Specialist).**

Future: (i) Many potato species have striking foliage and flower characteristics that have potential for use as ornamentals; research will be conducted to explore the possibility of utilizing potato species in the ornamental industry. (ii) Screening of material for tuber quality traits under field conditions will be continued and expanded further. (iii) Exploration of whether potato species sexually isolated from cultivated potato can be put in a form more amenable for use by potato breeders, i.e., by chromosome doubling or by identifying desirable clones with 2n gamete production. (iv) The recent funding obtained for the Cornell-led sequencing of the tomato genome also will have a positive impact on the value of the potato germplasm collection to scientists. The close relatedness of tomato and potato will allow the use of the tomato sequencing data for the identification of valuable genes in potato.

D 2. Outreach.

Professional outreach. Distribution of germplasm and related information to any *bona fide* user is the major role of the Inter Regional Potato Introduction Project. An E-mail group to notify 300 frequent users of new accessions was created two years ago, and resulted in a significant increase in the number of orders. An average of 7-8 queries are received each day. During the current project cycle, a samples of 26,702 accessions were shipped within the U.S. The herbarium also sends mounted specimens to herbaria located where the specimens were originally collected and to other national herbaria. NRSP-6 is a leading member of the Potato Association of America and an organizer of the International Solanaceae Congresses at roughly five-year intervals.

The Project website allows a cooperator to view information brochures, procedures (e.g., chromosome counting, crossing plants, tissue culture, etc.) and administrative reports (annual reports, budget requests, and regional distribution reports from TAC members) online. The Project web site is linked to GRIN and to IPD (the Intergenebank Potato Database), and NRSP-6 sends data regularly to IPD. GRIN allows a cooperator to view collection and evaluation data of any accession in the Inter Regional collection. IPD includes potato genebanks located in Peru, the Netherlands, Germany, United Kingdom, Russia, Argentina and the U.S. (this project). The data from all genebanks that hold a given accession can be pooled, allowing a large effective increase in the screening capacity of any research program. IPD is widely used by the potato research community. Agriculture and Agrifood Canada will also soon be linked to the Project website.

The Project Leader is Editor in Chief of the American Journal of Potato Research, a peer-reviewed research journal published by the PAA. This is a source of the high visibility enjoyed by NRSP-6 in the potato research community. The NRSP – 6 Taxonomist serves on the Editorial Boards of three refereed journals including the American Journal of Botany, and has been in demand for presentations on potato taxonomy, including 16 invited lectures around the U.S., and 18 international lectures during the project period.

Industry outreach. The Project Leader has accepted an invitation to be one of the speakers at the 2005 National Seed Potato Seminar, hosted by the National Potato Council and the Michigan Potato Industry Commission. Five hundred growers and industry supporters are expected to attend.

Popular outreach. NRSP-6 participates in extension activities at PARS and other research stations by providing wild potato species for demonstration during field days. The potato germplasm collection project is toured by student groups and is popular with the local community. A popular brochure describing the collection was prepared in 2004 (Martin, 2004). NRSP-6 has been featured in popular media including Business Week and Spudman magazines (2003), The Potato Grower (2002), The Grower (1999) and Diversity magazine (1999), The Potato Grower (1998) and ARS's Agricultural Research magazine (2002), and a local newspaper feature (2000). Ruth Ozeki, novelist, visited NRSP-6 to gather information for her future book on potatoes (2001). NRSP-6 was also featured in a public Television documentary "Natural Heritage Project" filmed at Chaco Canyon, NM (1999).

D. 3. Education and training

Education. As part of the faculty-status relationship with the University of Wisconsin, and in return for many in-kind contributions, NRSP-6 lends its expertise to teaching and advising programs in the Horticulture Dept. The Project Leader is a guest-lecturer in courses (e.g., Advanced Genetics) and supervises graduate and undergraduate research. The Project Taxonomist, based in Madison, teaches courses (Techniques of Plant Breeding, 1998 – 2002; Crop Evolution and Domestication, 1999) and advises graduate students.

Training. The outreach activities of the station inherently involve training components for users of potato germplasm. These include, for example, training and materials on specific propagation and crossing techniques for the different wild species, and on potato taxonomy and systematics. Many of the professional visitors to NRSP-6 come to receive such training.

E. Outcomes, impact and outlook for future impact

Due to the support of NRSP-6, genetic resources of potatoes are not only collected and preserved, but are also used by breeders and incorporated in released varieties. As noted in the Background section (B.2. a.), the extent of use of genetic resources in potato breeding is exceptionally extensive and effective. Germplasm from this project has contributed Golden nematode resistance; and resistance to cold sweetening, a serious processing defect that is costly to farmers. Perhaps even more important, because cultivated potato is subject to inbreeding, wild species have contributed heterosis to U.S. cultivars. An example is the cultivar 'Atlantic', bred by the Universities of Maine and Florida and ARS-Beltsville. Atlantic is one of the most widely adapted and grown potato varieties. It contains *S. chacoense* in its pedigree.

Given the high consumption of potatoes in the American diet, increasing the health value of the potato will have significant nutritional impact. The National Potato Promotion Board has identified increased nutritional value of potatoes as an important goal. Clones with high antioxidant activity or vitamin E are important to the industry. New diet trends, such as the search for low-carbohydrate foods, are expected to make the use of wild species even more important. The potato germplasm collection is a resource that will allow breeders to tailor potato varieties to public interest. For example, the ratio of amylose to amylopectin in potatoes can alter utilization by the body and subsequent caloric value. The genetic resources available through NRSP-6 may prove to contain desirable starch ratios or forms not found in cultivated potatoes.

Genomics has increased the value of the potato collection, because the resources in the collection can be explored with greater thoroughness and accuracy than before. The collection's future value will increase even farther if genetic engineering is accepted by consumers. The potato germplasm collection may even lead the way to increased acceptance. Such gene transfers between related plants could resolve consumer concerns about genes moved between unrelated species. For example, recently, a late-blight resistance gene from *S. bulbocastanum*, a wild potato in the NRSP-6 collection, was transferred to cultivated potato via genetic engineering.

Potato agriculture in all regions of the U. S., like all of U. S. agriculture, faces formidable challenges ahead. In 2003, the U.S. trade balance in potatoes was negative for the first time, by $35 million, due to increased imports from Canada where the frozen processing industry has expanded rapidly in the last decade due to favorable government policies, and has implemented more efficient new technology in the new processing plants. Chinese production of potatoes is increasing rapidly and export opportunities to China will be limited in future. The genetic resources available through NRSP-6 will be essential for maintaining the competitive quality of U.S. potato products and developing new potato products to increase demand in the U.S. domestic market.

F. Conclusions

F.1. NRSP-6 addresses 6 out of 7 ESCOP challenges, as described in Section B 1. With the advent of new tools such as genomics for using potato germplasm, present limitations on international germplasm exchange, and the new needs and opportunities illustrated in the ESCOP Challenges, this project has become more valuable than at any previous time.

F.2. The quality and efficiency of NRSP-6 operations are high. The Review Team believes that the future of potato germplasm is in great hands as long as this project is around. The collection is well managed for maximum retention of diversity and health of the accessions. Data management is in good shape—in fact NRSP-6 has been a leader in this area --and orders are filled promptly. Information provided by the staff and the website has added value and user-friendliness to the collection. One member of the Review Team (DS) contacted all U.S. potato breeding programs and all gave positive comments about the project.

NRSP-6 operates frugally, on a mix of funding from USDA, ARS; USDA, CSREES; other federal and private granting agencies (Appendix 4, list of grants); and the University of Wisconsin-Madison (UW Msn) Dept. of Horticulture, UW Msn Agricultural Research Stations, and the Wisconsin Agricultural Experiment Station (WAES). Considerable "in kind" support is also received from UW Msn and the WAES. NRSP-6 is characterized by positive, open and strong interactions between and among project leaders and staff at all levels. The unit is tightly linked internally and with other germplasm collections, both national and international.

The NRSP-6 Project Leader and Taxonomist are tenured full professors in the Dept. of Horticulture, College of Agriculture and Life Sciences at UW-Madison. They are subject to rigorous reviews by the ARS OSQR external review process. Both are actively involved in training graduate students and also have roles in instruction and outreach. The Project Leader serves as Editor in Chief of the refereed journal of the Potato Association of America. The NRSP-6 Project Manager (in 2003) and its greenhouse technician (in 2004) are both recipients of the National Plant Germplasm System Special Recognition Award. The quality of NRSP-6 support staff is widely recognized.

F.3. NRSP-6's support service to researchers is comprehensive, and pro-active in meeting needs and seeing future opportunities. Information is developed and published on breeding systems, genetics, and other attributes of the accessions**.** The development of enabling technologies such as molecular screening and the use of project facilities to enhance the delivery of usable germplasm, along with information to facilitate utilization of germplasm, is the focal point of the activity. Plant stocks from around the world are made available to let breeders use their own imagination to develop new traits. NRSP-6 is in a unique position to look at the overall germplasm picture, see opportunities, and prevent duplication of activities.

NRSP-6 germplasm stocks that possess specific desirable characteristics for industry are used by breeders and other plant scientists, both public and private, who respond to industry needs with improved germplasm and cultivars. Use of genetic diversity is more extensive for potato than for most other crops, due in large part to the support from NRSP-6.

Use of NRSP-6 germplasm is likely to increase as genomics tools for potato are developed. Another trend likely to increase use of the collection is a new generation of transgenic varieties based on gene transfer between related species. Related-species transgenics may be more acceptable to some consumers than transgenics using the current repertoire of genes from bacteria or unrelated model species. Related-species transgenics will require an intensified search for genes of nutritional and economic value in the NRSP-6 collection.

NRSP-6 serves consumers by its discovery in the collection of materials with enhanced nutrient content and health properties. The collection will allow development of new domestic markets and new uses for potatoes, for example, ready-to-eat "snackable" mini-tubers with various colors, shapes, and flavors.

The international work of NRSP-6 serves all U.S. citizens by opening doors to the United States for sharing genetic resources of potatoes and other crops in their centers of diversity. Former students from this project become ambassadors. Countries where potato is indigenous, such as Peru, Bolivia, and Colombia, have received many accessions distributed from NRSP-6. This distribution, free of charge, is the strongest support for the U.S. position in international negotiations in favor of free exchange of genetic resources among all countries.

G. Recommendations

G.1. Research support

Concentrate on projects that will have a high impact on markets, such as consumer health, product diversity, and also climate change. These are the projects that will have a high impact on the long-term survival of the project. To identify such projects, NRSP-6 should maintain and increase its interaction with the private sector. Activities in support of research to reduce production costs and reduce the environmental footprint of potato agriculture should continue.

Avoid a user fee system for distributions. Internationally, many countries are restricting access to their germplasm. The U.S. sets a precedent to the international community by providing germplasm from U. S. collections free of charge to all *bona fide* users. This practice strengthens the U.S. position in negotiations for open international access to germplasm for all countries.

Continue to work closely with geneticists and breeders to provide interspecific "bridge" hybrids, in order to facilitate rapid and economical use of wild potato germplasm in breeding programs. These are tetraploid parental stocks having disease resistance and physiological characteristics of interest.

To the extent possible, keep track of the impact of germplasm distributed, for example as parents in new varieties. Success stories should be highlighted in an updated brochure and distributed to the public. One member of the staff could be assigned to this task on a regular basis.

Contact the NPGS Ornamentals curator located at Ohio State University (Dr. David Tay) about how to explore potential of potatoes to find a niche in the booming ornamentals market.

Web site:

Add value to the Project's high-quality website for researchers by exploring professional development and maintenance, via ARS or UW, of an attractive, general-interest home page. Include clear links to the technical information that research users of the website find so useful.

Continue to improve the web site with frequent updates and user-friendly applications. For example, provide a link to the tomato sequencing project, which will impact future potato research because of the close relationship between these two species.

G. 2. Procedures

Consider the usefulness and technical feasibility (including costs and labor requirements) of distributing alternate materials such as DNA, pollen, frozen plant tissues, or mini-tubers, as appropriate for the specific request.

Explore the feasibility of a barcode system to simplify the tracking process and minimize human error, although the staff does a good job in tracking the collections.

Keep track of Website hits.

G. 3. Facilities

Personnel appear to be the limiting factor to the capacity for handling germplasm. More could be done using existing facilities, with additional personnel.

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List of acronyms and abbreviations

AREERA	Agricultural Research, Extension and Education Reform Act of 1998
ARS	Agricultural Research Service, USDA
CGC	Crop Germplasm Committee
CIP	Centro Internacional de la Papa (International Potato Center), Peru
CSREES	Cooperative State Research, Extension and Education Service, USDA
ESCOP	Experiment Station Committee on Operations and Policy
GRIN	Genetic Resources Information Network, NPGS
Gp	Group (botanical designation)
IR	Inter-Regional Project
MTA	Material Transfer Agreement
NC	North Central
NCGRP	National Center for Genetic Resources Preservation
NE	North Eastern
NPGS	National Plant Germplasm System
NRSP	National Research Support Project
NSF	National Science Foundation
OSQR	Office of Scientific Quality Review, ARS
PARS	Peninsular Agricultural Research Station
S	*Solanum*
S	Southern

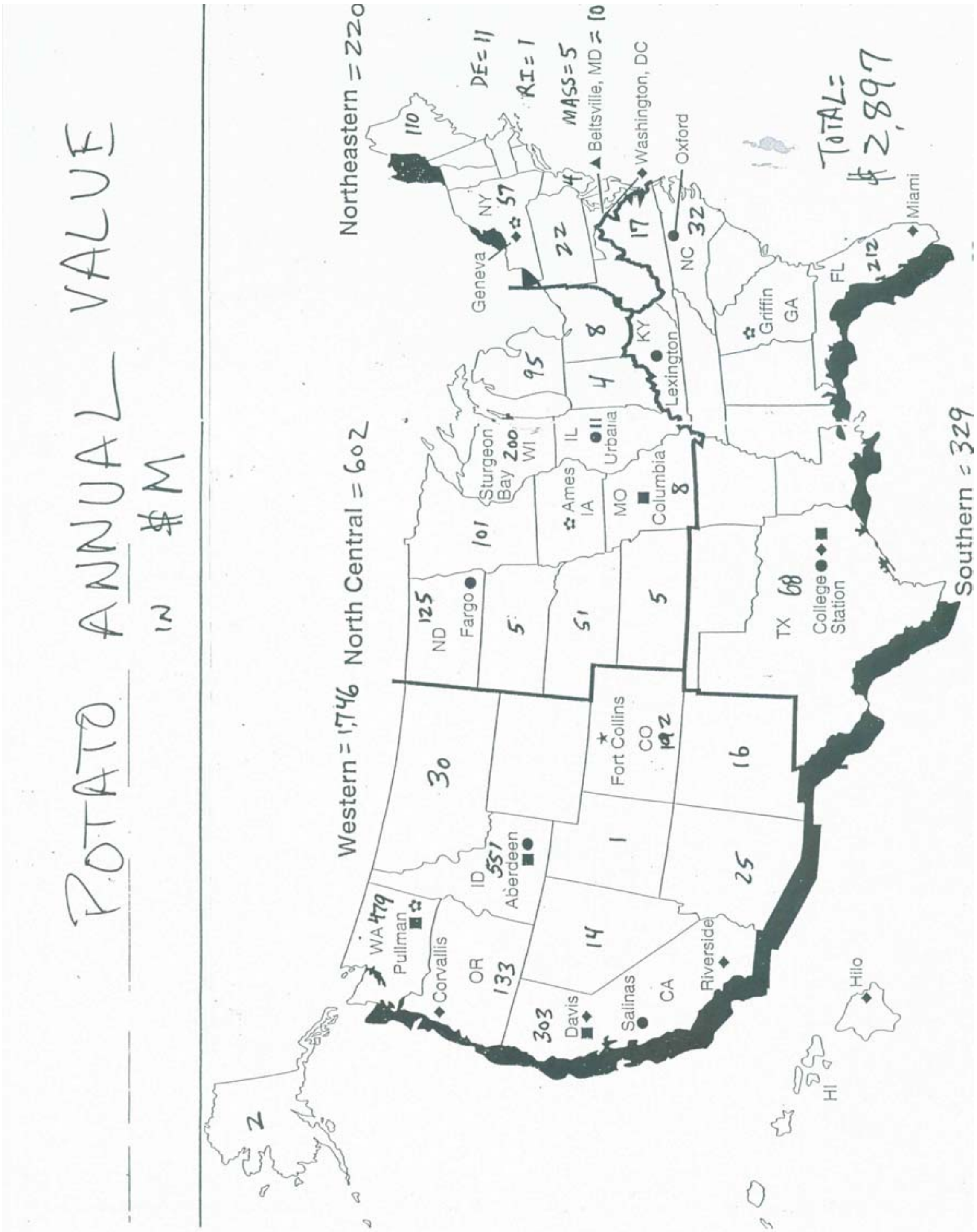
SAES	State Agricultural Experiment Station
TAC	Technical Advisory Committee
USDA	United States Department of Agriculture
W	Western
WAES	Wisconsin Agricultural Experiment Station

Appendices

1. Value of U.S. potato crop, by state (map)
2. Cost to an individual program to use potato germplasm, if there were no NRSP 6
3. NRSP-6 structure and funding sources
4. Grants awarded to NRSP-6 during the current project cycle
5. NRSP-6 personnel, by funding source
6. NRSP-6 collaborators and germplasm recipients
7. Research support: NRSP-6 systematics and taxonomy publications during current project cycle
8. Research support: Enabling techniques developed by NRSP-6 during current project cycle
9. Research support: Preliminary characterizations conducted by NRSP-6 during current project cycle
10. Map of the National Plant Germplasm System (NPGS)

Appendix 1. Value of the U.S. potato crop, by state.

a. Map showing data from individual state agricultural statistics webpages for the latest year available, 2002 or 2003.



Appendix 1. Value of the U.S. potato crop, by state.

b. Data from the National Agricultural Statistical Service, Potatoes summary 2002, Published Sept 18, 2003. http://usda.mannlib.cornell.edu/usda/

Potatoes: Production, Farm Disposition, Price, and Value by State, and United States, 2002 Crop

State	Prod	Total Used for Seed	Farm Disposition: Where Grown: Seed, Feed, Home	Farm Disposition: Where Grown: Shrink and Loss	Farm Disposition: Sold	Price per Cwt	Value of: Prod	Value of: Sales
	1,000 Cwt	*1,000 Cwt*	*1,000 Cwt*	*1,000 Cwt*	*1,000 Cwt*	*Dols*	*1,000 Dols*	*1,000 Dols*
AL	555	53	10	23	522	11.60	6,438	6,055
AZ	2,106	152	2	14	2,090	13.40	28,220	28,006
CA	17,017	1,272	78	1,263	15,676	17.50	296,907	274,896
CO	30,153	1,887	1,465	2,958	25,730	6.40	192,198	164,360
DE	936	56	5	37	894	10.00	9,360	8,940
FL	9,659	896	1	50	9,608	14.00	135,448	134,705
ID	133,385	7,920	1,440	8,650	123,295	5.00	666,925	616,475
IL	1,984	143	35	42	1,907	5.80	11,507	11,061
IN	728	63	4	29	695	5.85	4,259	4,066
KS	986	67		30	956	8.25	8,135	7,887
ME	16,960	1,386	310	790	15,860	7.05	119,568	111,813
MD	1,175	71	34	33	1,108	9.30	10,928	10,304
MA	816	65	5	16	795	7.30	5,957	5,804
MI	13,878	1,123	205	1,400	12,273	7.80	108,248	95,729
MN	18,700	1,098	130	1,400	17,170	6.15	115,005	105,596
MO	1,296	160	1	13	1,282	6.50	8,424	8,333
MT	3,224	254	145	142	2,937	8.25	26,598	24,230
NE	8,611	611	149	612	7,850	6.10	52,527	47,885
NV	2,660	180		320	2,340	5.00	13,300	11,700
NJ	715	31	3	21	691	8.20	5,863	5,666
NM	2,336	130	101	50	2,185	6.55	15,195	14,284
NY	5,500	488	100	350	5,050	11.80	64,900	59,590
NC	3,570	252	29	111	3,430	8.35	29,810	28,641
ND	23,460	2,242	450	2,650	20,360	6.25	146,625	127,250
OH	903	89	2	12	889	10.30	9,301	9,157
OR	24,936	1,021	266	1,386	23,284	5.65	141,269	131,755
PA	2,590	276	38	78	2,474	9.15	23,699	22,637
RI	118	11			118	7.75	915	915
SD	330	27	14	40	276	10.50	3,465	2,898
TX	5,360	352	40	100	5,220	10.70	57,462	56,031
UT	244	17	2	10	232	10.00	2,440	2,320
VA	1,386	98	2	50	1,334	12.70	17,602	16,942
WA	92,400	3,960	300	6,500	85,600	5.55	512,820	475,080
WI	31,125	1,848	265	1,775	29,085	6.90	214,763	200,687
US	459,802	28,299	5,631	30,955	423,216	6.69	3,066,081	2,831,698

Potatoes 2002 Summary
September 2003

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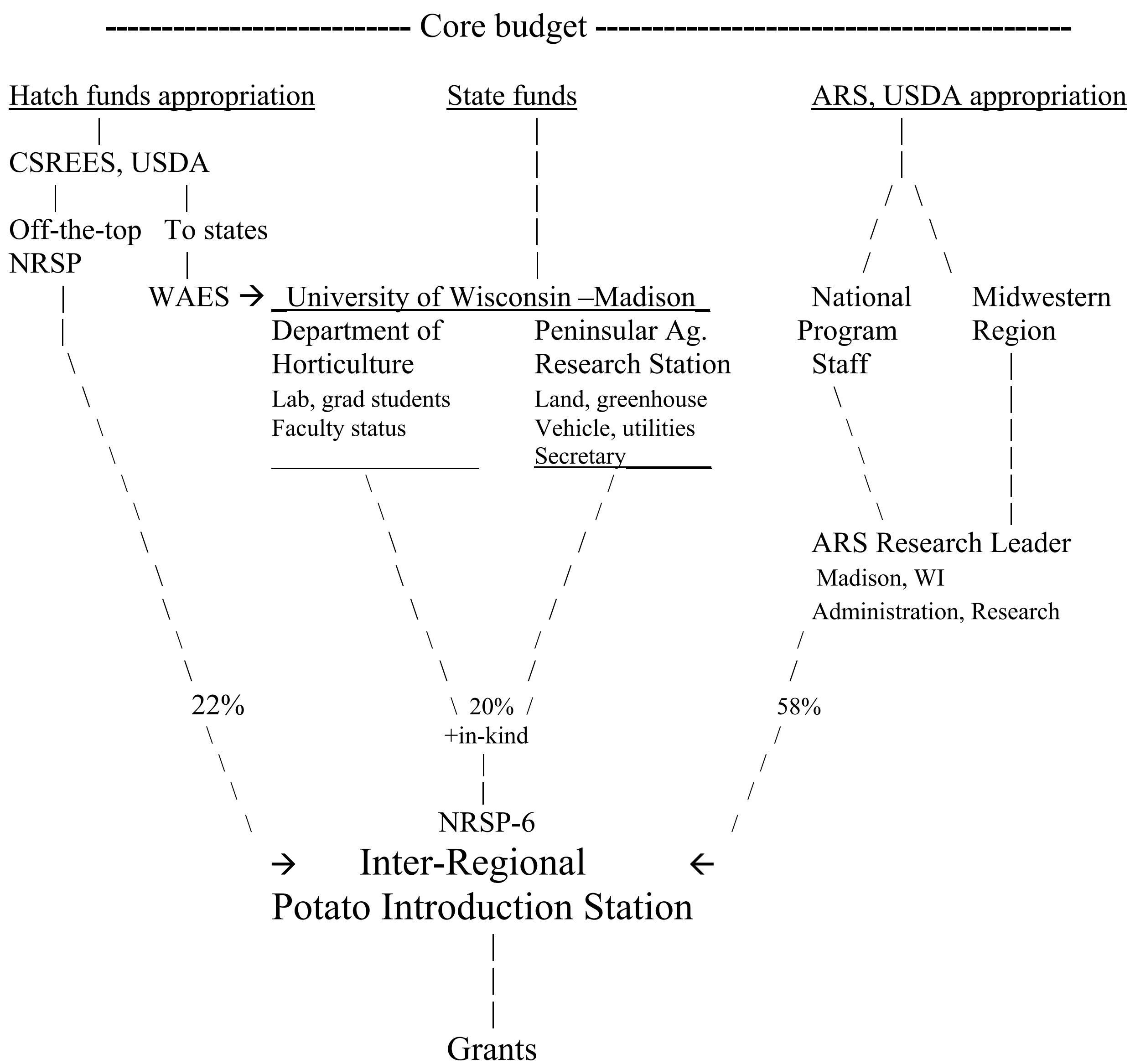
Agricultural Statistics Board
NASS, USDA

Appendix 2. What would it cost for an individual program to use potato germplasm resources, if there were no NRSP-6?			
Required step (now done by NRSP-6)	**Action to accomplish required step**	**Cost**	
		Cost in time	**Cost to budget**
Identify species most likely to contain genes of interest	Literature search and contact potato botanists	Library research and correspondence over several months	Say, one months' scientists salary and access to taxonomist(s)
Find out how to get a sample of the most likely species	Survey U.S. potato breeders in case species is in U.S. and the holder will share. If not, must collect.	In above tasks, look for sources. Add months or more if MTAs are required.	Part of the above month's salary. Costs of MTA: Salaried time of university tech transfer staff, university legal council fees
Plan an expedition to collect in country of origin	Herbarium research to find sites; contact in-country partner who knows season to collect and can recognize species in wild	Weeks or months, including travel to herbaria, waiting for correspondence replies.	Several weeks' scientist salary. Travel costs, est. $2000 or more if international herbaria must be consulted
Organize inter-government agreement; including acceptable benefit sharing	Get approval from Potato Crop Germplasm Com; ask ARS Plant Germplasm Lab to negotiate conditions w/ national authorities	Months to years, simultaneous with other activities	Benefit sharing can be costly, e.g. graduate student assistantship; training visit to U.S. for national staff; build facilities in source country. Scientist time to arrange and implement.
Learn about regulations and procedures for introduction of potatoes into the U.S.	Contact APHIS re their regs; contact ARS quarantine re space available and waiting time	One or two years to complete quarantine requirements	Negligible.
Conduct the exploration	Travel, meet in-country partner, collect, share samples	Several weeks, once the right time of year has arrived	International travel costs, including in-country partner expenses. Scientist salary, 1 month.
Keep material alive and disease-free so it is not lost while studied and used	Library research, ask other potato researchers, trial and error	Learning time depends on skill, luck. Extra time to grow unadapted or wild materials	Est. 1 mo. scientist salary for learning phase; 1 yr technician salary -maintain plants. Greenhouse and field space charges; cost of supplies
Characterize the new material for the trait of interest	Recruit collaborators in plant pathology, nutrition, other specialties. Lab, field, or greenhouse expts.	One or two growing seasons	Scientists salary, 1 mo. Technician salary, 1 yr. Greenhouse and field charges; supplies
Avoid genetic mixtures, loss of valuable genes, or mis-identifications during grow-outs.	Library research; ask germplasm curators and other potato researchers; trial and error	Staff time for hand pollination and extra measures necessary to avoid mixtures	Est. 1 mo. scientist salary Technician yr/salary included in above two steps
Learn breeding system of each species, inter-specific crossing techniques and ranges	Library research; ask other potato researchers; trial and error	Varies dep. on skill, luck. Staff time to pollinate or embryo rescue	1 mo. scientist salary for learning phase; 1 yr technician salary. Greenhouse and field space charges; supplies
Subtotal of investments	**After this point → the breeder can finally begin making crosses for variety development**	**4 to 5 years** **→ before a breeding program can begin.**	**Salary costs for:** **18 mos potato scientist** **3 yrs technical staff** **Add'l. salary time for taxonomist(s), tech transfer staff, university lawyers** **Travel costs: U.S. + international** **Facilities costs for greenhouse, field, laboratory; utilities** **Funds for benefit sharing**

Appendix 2. What would it cost for an individual program to use potato germplasm resources, if there were no NRSP-6?			
App. 2, con't. **Additional steps if collected germplasm will be preserved :**			
Maintain germplasm in viable and health state	Re-propagate whenever viability of stored material drops		Temporary staff (student workers) at peak seasons Technician, costed above, to supervise
Record keeping	Trial and error	Staff time for database mgt.	Scientist time to plan records system Technician or summer help, costed above
Additional steps if collected germplasm will be shared with other users:			
Records electronically available to share	Ask other germplasm curators; trial and error	Staff time for database mgt.	Part time technician salary Computer equipment and IT support
Inform other US researchers about the availability of this new resource	Decide if material will be shared; if so, before or after collector's research is complete and published?	Quick; post on website	Part of above
Provide rapid delivery of high-quality, disease free samples, including associated information	Propagate extra stock for distribution. Develop request filling and tracking protocols	Staff time for extra steps to propagate clean material and process requests	Two long-term technicians Temporary staff at peak seasons
Characterize accessions; develop broad knowledge of potato germplasm, advise other researchers	Rare that any researcher would be able to do this without establishing an individual genetic resources collection	A lifetime of work and study	Long-term scientist salary Greenhouse, field and laboratory space and supplies
Subtotal to preserve and share		**Another year before germplasm is ready to share. Long-term investment to preserve**	**Additional long-term costs: A second potato scientist, 2.5 more technicians. Additional field, greenhouse, lab; utilities; computer, and IT support costs.**

Appendix 3.

Structure and funding sources
NRSP-6
Inter-Regional Potato Introduction Station



Appendix 4.

NRSP-6
Interregional Potato Introduction Project

Grants awarded to NRSP-6 during the current project cycle

Collecting
Costa Rica USDA/NPGS 1996 $13K
Mexico USDA/NPGS 1997 $10K
Peru USDA/NPGS 1998 $22K
Peru USDA/NPGS 1999 $14K
Honduras and Panama USDA/NPGS 2000 $14K
Nematode resistance in SW USDA/NPGS 2002 $3K
Total: $76K

Taxonomy
USDA/ARS 1996-97 $50K
USDA/ARS 1997 $23K
Wisconsin Vegetable Board 1998 $6K
USDA/FAS 1998-01 $30K
UW-Madison 2000 $1K
Org Econ Coop & Dev 2000-01 $5K
USDA NRI 2000-03 $220K
NSF 2004-08 $945k
Total: $1280K

Evaluation data documentation
USDA/NPGS 2002 $15K
Total: $15K

Evaluation
Late blight screening USDA/ARS 1997-01 $110K
Tuber calcium genetics USDA/ARS $28K
Tuber calcium breeding Wisc Potato and Veg Growers $6K
Total: $144K

Preservation
Status of genetic diversity USDA/ARS 2001 $13K
Making herb specs National Arboretum 2002 $5K
Total: $18K

TOTAL = $1.53 M

Appendix 5.

NRSP-6
Interregional Potato Introduction Project

Personnel:
Source of funds, function, and employer.

Appendix 5. NRSP-6 Personnel: Source of funds, function, and employer.			
Source of funds	**Scientist, Professional or Technician Years, and Function**	**Employer**	**Remarks**
ARS	0.05 ARS Research Leader, Madison 1.00 ARS Geneticist, Project Leader (80% research support, 20% research) 1.00 ARS Research Botanist (40% research support, 60 % research) 1.00 Database mgt, research support 1- temp. Summer student help	Federal	
Subtotal, ARS	3.05 plus summer student help		
NRSP	0.46 Senior technician (80% time, shared with UW) 1.00 Germplasm Management Technology Specialist **(*)** 0.75 Germplasm Distribution Technician, plant care 0.20 Greenhouse and Field Manager, characterization. 0.50 Graduate Student Assistant 1-2 temp. Summer student help	State	Senior technician supervises other state employees; serves as acting project leader as necessary
Subtotal, NRSP	**2.91** plus summer student help		
WAES	0.34 Senior Technician (80% time, shared with NRSP) 0.80 Greenhouse and Field Manager Shared Secretary (with Peninsular Ag Expt. Station)	State	
Subtotal, WAES	1.14 plus shared Secretary		
Total	7.30		**NRSP funds augmented by 4.2 additional staff plus shared secretary and additional summer help**

(*) See Appendix 7 for the contributions of this ESCOP-funded position (held by A. H. del Rio)

Appendix 6.

NRSP-6
Inter-Regional Potato Introduction Project

Collaborators and germplasm recipients
during the current project cycle

SAES collaborators	ARS collaborators	Private sector users	Other U.S. users	International Users
Alaska	**Western Region**	**Machado Farms**	**Yale Univ.**	**Argentina**
Arizona	**(Washington, Idaho)**	**Maxygen**	**St. Louis Univ.**	**Belarus**
California	**North Central Region**	**Simplot**	**The Inst. for**	**Belgium**
Colorado	**(Wisconsin)**	**Zeneca Ag Products**	**Genomic Res.,**	**Bolivia**
Florida	**Headquarters**	**Sweetgrass Farm**	**TIGR**	**Canada**
Hawaii	**(Beltsville)**	**Dow**	**U.S. Botanic**	**China**
Kentucky		**Ronnigers Potato Farm**	**Garden**	**Colombia**
Idaho		**Bejo Seeds**		**Czech Rep.**
Iowa		**Monsanto**	**Noble Foundation**	**Ethiopia**
Maine		**Plant Biotics**	**Winrock Internat'l.**	**Finland**
Maryland		**Seminis**	**Brigham Young U.**	**France**
Massachusetts		**Big John's Pumpkins**	**Nebraska Seed**	**Germany**
Michigan		**Frito Lay**	**Certification**	**Guatemala**
Minnesota		**Better Buy Two**	**Sul Ross State Univ.**	**Hungary**
New York		**Phillip Morris**	**Littleton Hist. Mus.**	**Iceland**
North Carolina		**Small Potatoes**	**Backyard**	**India**
North Dakota		**Quantum Tubers Corp**	**Gardner**	**Indonesia**
Ohio		**Tissue-Grown Corp.**	**Resource**	**Italy**
Oregon		**Scatterseed Project**	**Center**	**Japan**
Pennsylvania		**DuPont**	**Aztec Ruins**	**Korea, S.**
Texas		**SLV Research**	**Eastern Native**	**Kuwait**
Virginia		**Meristem Inst.**	**Seed Conserv'y**	**Mexico**
Washington		**Orca Farm**	**Kampong**	**Netherlands**
Wisconsin			**Publications**	**Peru**
				Romania
				Russia
				Spain
				Switzerland
				Turkey
				U K
				World Bank
				Internat. Potato Center

Appendix 7.

NRSP – 6

Inter-Regional Potato Introduction Project

Research Support: Potato systematics and taxonomy

Publications from the current project cycle

Spooner, D.M. and R. Castillo-T. 1997. Reexamination of series relationships of South American wild potatoes (Solanaceae: Solanum sect. Petota): evidence from chloroplast DNA restriction site variation. Amer. J. Bot. 84:671-685.

Rodríguez, A. and D.M. Spooner. 1997. Chloroplast DNA analysis of Solanum bulbocastanum and S. cardiophyllum, and evidence for the distinctiveness of S. cardiophyllum subsp. ehrenbergii (sect. Petota). Syst. Bot. 22:31-43.

Castillo, R. and D.M. Spooner. 1997. Phylogenetic relationships of wild potatoes, Solanum series Conicibaccata (sect. Petota). Syst. Bot. 22:45-83.

Spooner, D.M., M.L. Ugarte, and P.W. Skroch. 1997. Species boundaries and interrelationships of two closely related sympatric diploid wild potato species, Solanum astleyi and S. boliviense based on RAPDs. Theor. Appl. Genet. 95:764-771.

Spooner, D.M. 1998. Germplasm availability, species boundaries, and interrelationships of wild and cultivated potatoes (Solanum sect. Petota). Monogr. Syst. Bot., Missouri Bot. Gard. 68:477-487.

Spooner, D.M. and J.B. Bamberg. 1998. Potato Herbarium (PTIS). U.S.D.A. Misc. Publ. 1343:53-56.

Spooner, D.M., R. Hoekstra, R.G. van den Berg, and V. Martínez. 1998. Solanum sect. Petota in Guatemala: taxonomy and genetic resources. Amer. J. Potato Res. 75:3-17.

Van den Berg, R.G., J.T. Miller, M.L. Ugarte, J. P. Kardolus, J. Villand, J. Nienhuis, and D.M. Spooner. 1998. Collapse of morphological species in the wild potato Solanum brevicaule complex (sect. Petota). Amer. J. Bot. 85:92-109.

Clausen, A.M. and D.M. Spooner. 1998. Molecular support for the hybrid origin of the wild potato species Solanum ´ rechei (Solanum sect. Petota). Crop Sci. 38:858-865.

Spooner, D.M. 1998. Exploring options for the list approach, plant genetic resources for food and agriculture in situ and ex situ: where are the genes of food security likely to come from? pp. 133-164 In: Proceedings of an international workshop, Interdependence and food security: which list of PGRFA for the future multilateral system? Instituto Agronomico per L'Oltremare, Florence, Italy.

Miller, J. and D.M. Spooner. 1999. Collapse of species boundaries in the wild potato Solanum brevicaule complex (Solanaceae, S. sect. Petota): molecular data. Plant Syst. Evol. 214:103-130.

Contreras-M., A. and D.M. Spooner. 1999. Revision of Solanum section Etuberosum. In Nee, M., Symon, D. E., and Jessop, J. P. (eds.). Solanaceae IV: advances in biology and utilization. Royal Botanic Gardens, Kew, U.K. pp. 227-245.

Knapp, S. and D.M. Spooner. 1999. A new name for a common Ecuadorian and Peruvian wild tomato species. Novon 9:375-376.

Spooner, D.M., A. Salas-L., Z. Huamán, and R.J. Hijmans. 1999. Wild potato collecting expedition in southern Peru (Departments of Apurímac, Arequipa, Cusco, Moquegua, Puno, Tacna) in 1998: taxonomy and new germplasm resources. Amer. J. Potato Res. 76:103-119.

Peralta, I.E. and D.M. Spooner. 2000. Classification of wild tomatoes: a review. Kurtziana 28:45-54.
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Appendix 8.

NRSP – 6

Inter-Regional Potato Introduction Project

Research Support:
Enabling techniques and information developed during the current project cycle

The Germplasm Management Technology Specialist whose position is supported by ESCOP NRSP-6 funding (A. H. del Rio) contributed to 16 out of the 18 publications and abstracts in this list, or 88% of the published enabling techniques developed by NRSP-6 to make collection, preservation, and use of potato germplasm more efficient (first author on 10 of the 18).

The gist of each of the following accomplishments is presented in question and answer format.

1. Are reputed duplicate germplasm samples in CIP and USA potato genebanks genetically identical? A: Not always. 2004. del Rio, A., J. Bamberg and Z. Huaman. Assessment of putative identical germplasm collections at CIP and US Potato genebanks determined by RAPD and SSR markers. [submitted Abstr]

2. Do genetic differences among populations of *S. verrucosum* (a diploid inbreeder) follow a pattern in geographic variables at their sites of origin in the wild, and their proximity to other potato species? A: Yes. 2004. del Rio, A. H. and J. B. Bamberg. Geographical parameters and proximity to related species predict genetic variation in the inbred potato species *Solanum verrucosum* Schlechtd. Crop Science 44: in press.

3. Is it likely that recessive traits will be noticed in polysomic polyploid species? A: No. Bamberg, J.B. and A. del Rio. 2003. Hypothetical obscured recessive traits in tetraploid *Solanum* estimated by RAPDs. Presented at 87th Annual Meeting of PAA, Spokane, WA, Aug. 10-14, 2003. p. 78. [Abstr]

4. Are there many alleles within genebank populations that are likely to be lost by current seed increase methods? A: No. 2003. Bamberg, J. B. and A. H. del Rio. Vulnerability of alleles in the US Potato Genebank Extrapolated from RAPDs. Am J. Potato Res. 80:79-85.

5. Do newly-collected populations undergo a large genetic shift when they are subjected to seed increase at the genebank for the first time? A: No. 2003. del Rio, A. H. and J. B. Bamberg. The effect of genebank seed increase on the genetics of recently collected potato (*Solanum*) germplasm. Am J. Potato Res 80:215-218.

6. Does any descriptive data already in the genebank allow us to predict which populations will be frost hardy? A: Yes. 2003. Hijmans, R.J., M. Jacobs, J.B. Bamberg, and D.M. Spooner. Frost tolerance in wild potato species: Assessing the predictivity of taxonomic, geographic, and ecological factors. Euphytica 130:47-59.

7. Do you sometimes get different genetic samples by collecting tubers vs seeds? A: Yes. 2003. Moreyra, Rocio, J. Bamberg and A. del Rio. 2003. Genetic consequence of

collecting tubers vs. seeds of wild potato species indigenous to the USA. Presented at 87th Annual Meeting of PAA, Spokane, WA, Aug. 10-14, 2003. p. 50. [Abstr]

8. Do genetic differences among populations of *S. sucrense* (a tetraploid outcrosser) follow a pattern with geographic variables at their sites of origin in the wild? A: No. 2002. del Rio, A. H. and J.B. Bamberg. Lack of association between genetic and geographic origin characteristics for the wild potato *Solanum sucrense* Hawkes. Am. J. Potato Res. 79:335-338.

9. Are the reputed duplicate population in different potato genebanks consistently genetically equivalent? A: No. 2001. Bamberg, J. B., S. D. Kiru and A. H. del Rio. Comparison of reputed duplicate populations in the Russian and US potato genebanks using RAPD markers. Am. J. Potato Res. 78: 365-369.

10. Do genetic differences among populations of *S. jamesii* (diploid outcrosser) and *S. fendleri* (disomic tetraploid inbreeder) follow a pattern with geographic variables at their sites of origin in the wild? A: No. 2001. del Rio, A.H., J.B. Bamberg, Z. Huaman, A. Salas, and S.E. Vega. Association of eco-geographical variables and genetic variation in native wild US potato populations determined by RAPD markers. Crop Science 41:870-878.

11. Does the intrapopulation heterogeneity of different species have a practical affect on sample variation that can impact genebank decisions? Yes. del Rio, A. H. and J. B. Bamberg. 2001. Genetic heterogeneity among breeding systems of potato species and its ramifications in germplasm conservation. Am J. Potato Res. 78:452. [Abstr].

12. Do populations vary in their genetic homogeneity, and therefore the need to screen individuals before breeding? A: Yes. 2000. Bamberg, J., C. Singsit, A. H. del Rio and E. B. Radcliffe. RAPD analysis of genetic diversity in *Solanum* populations to predict the need for fine screening. Am. J. Potato Res. 77:275-278.

13. If critical data is missing about a population, can RAPD markers clearly place it in its proper species group and determine whether it is genetically unique and therefore worth keeping? A: Yes. 2000. del Rio A. H. and J. B. Bamberg. RAPD markers efficiently distinguish heterogeneous populations of wild potato (*Solanum*). Genetic Resources and Crop Evolution 47:115-121.

14. Are genetic shifts in some populations occurring because more vigorous seedlings are being selected for transplanting? A: Yes. Bamberg, J. B. and A. H. del Rio. 2000. Genetic shifts in potato genebank populations by unintentional seedling selection. Report to the North Central Regional -84 Potato Genetics Technical Meeting. Des Plaines, IL, Dec 7, 2000. [Abstr].

15. Do some wild potato species populations have a stable genetic dependence on GA presoaking of seeds for germination? A: Yes. 1999. Bamberg, J. B. Dependence on exogenous gibberellin for seed germination in *Solanum acaule* Bitter and other *Solanum* (potato) species. Am. J. Potato Res. 76:351.

16. Is the gibberellin mutant previously discovered and known from a single population actually rare in the overall collection? A: No. 1999. Bamberg, J. B. Screening for gibberellin deficiency mutants in *Solanum tuberosum* ssp. *andigena* Am. J. Potato Res. 76:321-322.

17. Can sample variation skew the apparent similarity of populations? Yes. del Rio, A.H. and J.B. Bamberg. 1998. Effects of sampling size and RAPD marker heterogeneity on the estimation of genetic relationships. Am. J. Potato Res. 75(6):275. [Abstr].

18. Is the sample in the genebank always genetically equivalent to the population in the wild from which it was collected, sometimes many decades ago? No. 1997. del Rio, A.H., J.B. Bamberg, Z. Huaman, A. Salas, and S.E. Vega. Assessing changes in the genetic diversity of potato genebanks. 2. *In Situ* vs *ex situ.* Theor. Appl. Genet. 95(1/2):199-204.

19. Is significant genetic diversity lost by the current process of seed increase on most populations? A: No. 1997. del Rio, A.H., J.B. Bamberg and Z. Huaman. Assessing changes in the genetic diversity of potato genebanks. 1. Effects of seed increase. Theor. Appl. Genet. 95(1/2):191-198.

20. Does apomixis exist in certain species and can we induce it for the benefit of potato breeding and germplasm management? A: In progress. Results suggest genetic parity of some progeny of highly heterozygous mothers, but proof through induction and definitive markers still needed.

21. How variable are allele frequencies in seed-increase progeny of highly heterozygous germplasm populations if one does not ensure equal representation of each mother plant? A: In progress. Seed yields across years vary substantially--measurement of genetic consequences is in progress.

Appendix 9.

NRSP – 6

Inter-Regional Potato Introduction Project

Research Support:
Preliminary characterizations conducted during the current project cycle

Preliminary evaluation facilitates further research and breeding with NRSP-6 germplasm.

A. The gist of each of the following accomplishments is presented in question and answer format.

1. Do model calcium accumulators deposit calcium differently in tubers vs shoots? A: Yes. 2004. Busse, J., J. Bamberg, and J. Palta. Understanding Genetic Variations for Calcium Accumulation Efficiency in Tuber and Aerial Shoot Tissues. Submitted for presentation at the 88th Annual Meeting of the Potato Assn of America meeting, Scottsbluff, NE. [submitted Abstr]

2. Do calcium and GA_3 interact in tuberization characteristics? A: Yes. 2004. Vega, S., J. Palta and J. Bamberg. Evidence for the mitigation of gibberellin deficiency symptoms by root zone calcium in GA-deficient mutants of potato. Submitted for presentation at the 88th Annual Meeting of the Potato Assn of America meeting, Scottsbluff, NE. [submitted Abstr]

3. Do GA dwarfs of different ploidy and genotypes respond identically as GA bioassay subjects? A: No. 2004. Vega, S., J. Bamberg and J.Palta. Characterization of gibberellin requirements for various diploid and tetraploid gibberellin deficient mutants. Submitted for presentation at the 88th Annual Meeting of the Potato Assn of America meeting, Scottsbluff, NE. [submitted Abstr]

4. Is an obscured, recessive purple-less allele widespread among Longipedicellata populations in the US and Mexico? Yes. 2004. Fernandez, C. and J. Bamberg. A new *Solanum fendleri* mutant lacking purple pigment. Submitted for presentation at the 88th Annual Meeting of the Potato Assn of America meeting, Scottsbluff, NE. [submitted Abstr]

5. Are new sources of nematode resistance available, and are their origins predictable by comparing holdings of different potato genebanks? A: Yes. 2004. Kiru, S, S. Makovskaya, J. Bamberg and A. del Rio. New sources of resistance to race Ro1 of the Golden nematode (*Globodera rostochiensis* Woll.) among reputed duplicate germplasm accessions of *Solanum tuberosum* subsp. andigena in the VIR (Russian) and US Potato Genebanks. Genet Resource & Crop Evol (accepted).

6. Are changes in membrane lipid physiology associated with cold acclimation in potato? A. Yes. 2004. Vega S.E., A.H. del Rio, J.B. Bamberg and J.P. Palta. 2003. Evidence for the up-regulation of stearoyl-ACP (delta9) desaturase gene expression during cold acclimation. Am J. Potato Res 81:125-135.

7. Can DNA markers associated with cold tolerance phenomena be identified? A: Yes. 2003. Vega S.E., A.H. del Rio, G. Jung, J.B. Bamberg and J.P. Palta. 2003. Marker-assisted genetic analysis of non-acclimated freezing tolerance and cold acclimation capacity in a backcross *Solanum* population. Am J. Potat Res. 80:359-369.

8. Can a isolated field plot near Lake Michigan provide the right environment for an effective local late blight test? Yes. Screened stocks in 2002-2003.

9. Do some non-Mexican species crossable with *tuberosum* have potent but variably homogeneous resistance to Late blight? A: Yes. 2001. Douches, D.S., J.B. Bamberg, W. Kirk, K. Jastrzebski, B.A. Niemira, J. Coombs, D.A. Biognin, and K.J. Fletcher. Evaluation of wild *Solanum* species for resistance to the US-8 genotype of Phytophthora infestans utilizing a fine-screening technique. Am. J. Potato Res. 78:159-165.

10. Do some *white-fleshed & -skinned* wild species easily crossable with *tuberosum* have high antioxidants? Yes. 2001. Hale, A. , L. Cisneros-Z., J. Bamberg and J. C. Miller. Identification of named varieties, advanced selections and accessions with high antioxidant activity for use in breeding potatoes for enhanced human health benefits. Am J. Potato Res. 78:455. [Abstr].

11. Is it possible to find clones in wild species with high leaf and low tuber glycoalklaloids (other than leptines)? A: Promising. 2001. Bamberg, J. B., S. Love and D. Corsini. Fine screening potato germplasm for high leaf and low tuber glycoalkaloids. Am J. Potato Res. 78:443. [Abstr].

12. Does redrying potato seeds reduce the effectiveness of hormone presoaking compared to direct sowing? A: No. 2000. Bamberg, J. B. Germination of gibberellin sensitive *Solanum* (potato) botanical seeds soaked in GA3 and re-dried. Am. J. Potato Res. 77:201-202.

13. Are there differences in the kinetics of cold acclimation in potato species that have similar overall maximum acclimation? A: Yes. 2000. Vega. S.E., J. Palta and J. Bamberg. Variability in the rate of cold acclimation and de-acclimation among tuber-bearing *Solanum* (potato) species. J. Am. Soc. Hort. Sci. 125:205-211.

14. Do protoplast fusion hybrids between *tuberosum* and *commersonii* have useful tuber traits? Yes. 1999. Chen, Y-K., J. Palta and J. Bamberg. Freezing tolerance and tuber production in self and backcross progenies derived from somatic hybrids between *Solanum tuberosum* L. and *S. commersonii* Dun. Theor. Appl. Genet. 99:100-107.

15. Do protoplast fusion hybrids between *tuberosum* and *commersonii* have outstanding cold acclimation like their wild parent? Yes. 1999. Chen, Y-K., J. Palta, J. Bamberg, H. Kim, G. Haberlach, and J. Helgeson. Expressions of nonacclimated freezing tolerance and cold acclimation capacity in somatic hybrids between hardy wild *Solanum* species and cultivated potatoes. Euphytica 107:1-8.

16. Do protoplast fusion hybrids between *tuberosum* and *commersonii* have outstanding cold hardiness like their wild parent? Yes. 1999. Chen, Y-K., J. Bamberg and J. Palta. Expression of freezing tolerance in the interspecific F1 and somatic hybrids of potatoes. Theor. Appl. Genet. 98:955-1004.

17. Does NRSP-6 –derived germplasm hold practical promise for mitigating potato insect problems? Yes. 1999. Thill, C., E. Radcliffe, D. Ragsdale, R. Hanneman and J. Bamberg. Identification of aphid resistant 4x potato germplasm for use in breeding. Am J Potato Res 76:385. [Abstr].

18. Do wild species differ in their nitrogen use characteristics and are some outstanding in ways that could be useful in breeding and developing screening methods? A: Yes. 1999. Errebhi, M., C. Rosen, F. Lauer, M. Martin, and J. Bamberg. Evaluation of tuber-bearing *Solanum* species for nitrogen use efficiency and biomass partitioning. Am. J. Potato Res. 76:143-152. and 1998. Errebhi, M., C. Rosen, F. Lauer, M. Martin, J. Bamberg, and D. Birong. Screening of exotic potato germplasm for nitrogen uptake and biomass production. Am. J. Potato Res. 75:93-100.

19. Do wild species differ in their tuber calcium accumulation and are some outstanding in ways that could be useful in breeding and developing screening methods? A: Yes. 1998. Bamberg, J., J. Palta, L. Peterson, M. Martin, and A. Krueger. Fine screening potato (*Solanum*) species germplasm for tuber calcium. Am. J. Potato Res. 75:181-186.

20. Do some non-Mexican species crossable with tuberosum have potent but variably homogeneous resistance to Late blight? A: Yes. 1997. Bamberg, J.B., D.J. Ormrod, and W.E. Fry. Screening wild Solanum germplasm for resistance to late blight. Am. Potato J. 74(6):417. [Abstr].

21. Do species of known resistance and newly-recognized sources hold up in the Toluca valley? Yes. 1997. Lozoya-Saldana, H., A. Hernandez, R. Flores, and J. Bamberg. Late blight on wild *Solanum* species in the Toluca Valley in 1996. Am. Potato J. 74:445. [Abstr].

22. Does potato tissue pH predict or explain traits related to processing quality or disease and stress resistances that are, themselves, more difficult to screen for? A: In progress. Preliminary results suggest differences among species.

B. NRSP-6 Germplasm characterization at collaborating sites

--Agrichemical impact on wild species gametes: CIP (Roca planned 2004)
--Antioxidants: Texas (Miller, 2001-), Wisconsin (Plhak 2002)
--Calcium (tuber) screening, genetics & physiology: Wisconsin (Palta 1997-)
--Calcium (tuber) breeding for better tuber quality: All Regions (Palta & US breeders 2004-)
--Collecting: Colorado, New Mexico, Arizona, Texas, Utah (many local botanists assisted 1992-), Idaho, Washington, Russia (Pavek 1999 & 2002, Brown 2002, Kiru 1999).
--Colorado potato beetle and virus resistance: Minnesota (Radcliffe 1997)
--Cultivar selection: Oregon (Mosley 2003)

--Frost tolerance and tuber type field validation: Oregon (Charlton 2002-03)
--Frost tolerance physiology, genetics and breeding: Wisconsin (Palta 1997-)
--Germination / Long-term viability: Colorado/NSSL (Wiesner 2003-)
--Glycoalkaloids: Idaho (Love 1999-04)
--Hormone mutants: Wisconsin (Palta 2003-)
--Jelly end disorder: North Dakota (Thompson 2003-4) and Texas (Drawe 2004).
--Late blight screening: New York (Fry 1996-00, visit 2000), Michigan (Douches 1997), British Columbia (Ng/Ormrod 1996-00), Mexico (Lozoya-S 1997-2004, visit 2000 & 2003), Russia/ Sakhalin Island (Kiru 1998), California (made hybrids for Baker 1998), Wisconsin (tuber increase for Helgeson 1998-99), Wisconsin (Stevenson 2000-01), Idaho (Novy 1999, 03), New Brunswick (Murphy 1999).
--Nematode resistance: Russia (Kiru 2003), Washington (collecting with Brown 2002)
--Nitrogen efficiency: Minnesota (Rosen 1997)
--Organic production: Wisconsin (Jansky 2003-04)
--Recessives detection when breeding autotetraploids: VIR (Kiru & Gavrilenko planned 2004)
--Rhizoctonia resistance: Alaska (Carling 1997-2000)
--Root screening: Wisconsin (Barak 1996)
--Tuberization of wild species in field growouts: Texas (Drawe 1998-00, visits 1998-00), North Carolina (Yencho 2003-2004), Florida (Snell 2002, visit 2002), Hawaii (Keyser 2003-2004, visit 2003).
--Tumor/cancer inhibition screening Wisconsin (Palta and Verma, 2003-).

Appendix 10.

Map of the
National Plant Germplasm System (NPGS)