NRSP-6
PROJECT RENEWAL PROPOSAL

for FY 2006-10

NRSP-6 Inter-Regional Potato Introduction Project: Acquisition, classification, preservation, evaluation and distribution of potato (*Solanum*) germplasm

Requested Duration: FFY 2006-2010
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A. PREREQUISITE JUSTIFICATION AND STATEMENT OF ISSUES:

A. 1. How is NRSP-6 service consistent with its research support mission?

a. Support activities. NRSP-6 is designated the sole official NPGS project filling the role of working potato germplasm collection for the US. The US is very poor in native potato (and most other crop) germplasm, but relatively rich in resources to preserve it. Thus, making the NRSP-6 resource freely available to other countries is a key part of US policy of reciprocity to encourage those countries to share their native germplasm with us. The best way to understand the importance of NRSP-6 is to imagine how the US would use potato germplasm resources if no genebank were present. Imagine a scenario in which an individual researcher wanted to investigate a certain trait in exotic potato relatives. How would he intelligently define what “potato relative” means until he had first developed taxonomic information on species boundaries and relatedness to cultivars? And after having determined a taxonomy, how could he hope for any eventual practical application to breeding or genetics without first determining the breeding system, requirements for growth, and interspecific crossing? If, having done this, he settled on a species to study, how would he get a sample? If it did not exist in the US or he could not find or obtain it from a fellow US researcher, could he organize an expedition to Latin America to collect samples for himself? If so, he would first have to gather and organize herbarium records to find out where his species grew and at what time of the year, and gain the expertise to be able to locate and identify it in its wild habitat. He would have to negotiate formal intergovernmental agreements to collect. Then too, potato is a “prohibited” plant, which means it cannot be imported except by APHIS permit. Thus, he would have learn the protocol for coordinating with ARS Quarantine for importation of potato germplasm, and wait one to two years until quarantine had tested it for exotic diseases. When he finally had it back in his lab in the US, would he immediately advertise its existence and availability to all potato researchers worldwide (not several years later when his research results appeared in print)? He would have to determine how to efficiently preserve the material—not only needing to know the requirements for keeping it alive over long-term experimentation, but developing the technology, information and facilities to test and keep the germplasm free of diseases (which in some cases are virtually incurable). If many items were collected, an accessible and accurate system of identifying and tracking individual units would have to be developed. Even if our imaginary researcher was successful in doing all these things and discovered and published a valuable trait, what would then become of the germplasm? If his peers wanted samples for breeding or studies of other traits, would our researcher commit to providing rapid delivery of high quality, disease free propagules to his colleagues indefinitely, and transfer this responsibility to a successor when he retired? Even if availability of the physical germplasm was assured, what about its associated data? Who would catalog, organize and disseminate all the useful information generated on these particular stocks by various researchers over time? Consider also that individual researchers typically study one thing on a limited number of taxa. Who would undertake the important role of understanding the totality of the germplasm in a general sense? That is, having the breadth of experience to notice phenomena that are unique and of potential value to the potato industry and see and report opportunities for cross links between research disciplines? Who would develop such broad perspective and use it to give advice to researchers who needed help in selecting the best stocks and techniques to answer their research questions? Who would take responsibility for asking and answering the questions pertinent to finding the most efficient genebank management of genetic diversity with respect to collecting, preserving and evaluating germplasm?

The implication should be obvious. The potato research and breeding community depends on NRSP-6 and its associated programs to perform and/or coordinate all of the above tasks. Doing without NRSP-6 would be like having everyone find, buy, organize, store and share books independently, without the coordinating service of a library. The great confusion and redundancy cost of the resulting disorganization would not just be borne by major potato breeding and research states, but would eventually filter down to everyone in the form of more federal taxes needed to support an inefficient public breeding program, and in the higher development and production costs passed from grower to processor to retailer to consumer.

b. development of enabling technologies. The genebank's role in efficient delivery of high quality germplasm requires development of some of the same technologies the recipient needs to exploit the germplasm. For example, both need to know the best techniques for germinating, growing and crossing the stocks. [see Appendices 2 and 3 for specific accomplishments]

c. sharing of facilities needed to accomplish high priority research. In some cases the demonstration and extension of technology is not the most practical approach, but rather for the genebank to simply perform the work on behalf of the recipient. Thus, we accept special orders to generate tubers, pretreat seeds for germination, prepare rooted cuttings for immediate planting, give away pollinating devices, etc. [see Appendix 4 for specific accomplishments].

d. facilitate a broad array of research activities. The breadth of potato science reflects the significance of potato as the 4th most important world food crop. Thus, NRSP-6 stocks are the subject of studies of breeding, genetics, cytogenetics, pathology, physiology, taxonomy, entomology, nematology, horticulture, biochemistry, and nutrition. For the years 1998-2003, we document 824 research papers, theses and abstracts that in some way involved the use of NRSP-6 stocks and services. [See Appendix 6 for details of support services provided and Appendix 3 for specific evaluation topics that promote stakeholder use of the germplasm].

A. 2. How does NRSP-6 pertain as a national issue?

Some states have more direct involvement in potato research or breeding, and some states have larger acreages. Some states, particularly those of the NCR do more of the type of broad, preliminary screening research that uses large number of germplasm items from the genebank. But all regions are actively using NRSP-6 stocks. As documented in Appendix 6, a total of 36 states and DC received germplasm in the past project term (eleven states in the NCR, eight in the NER, seven in the SR and eleven in the WR). Potato breeding and research programs in these states make important contributions to the states' economies, University reputations and agricultural competitiveness. As illustrated in section A., such programs that are pursuing progressive breeding and research using exotic germplasm (some in each region) often depend on NRSP-6 as the *only* practical source of the materials necessary for their work.

Furthermore, the benefits of NRSP-6 activities by potato states by no means stay within their borders. *Every* state at least has a significant and direct involvement in marketing, transportation and consumption of potato as a major part of the diet of its population. Citizens of *every* state have an interest in the influence potato is making on world food policy, considering how closely political stability is tied to economic and nutritional stability. Thus every state has a significant interest in potato improvement and should accept responsibility for paying a part of the cost.

If a crop could claim the following distinctions, the NRSP genebank that kept it would have a very convincing case for continuation with strong support, because it would have both a high priority with respect to national needs and extraordinary potential for significant impact:

- The major vegetable. Most widely grown and consumed vegetable in the US and world, being among the most palatable and versatile of foods, thus perhaps the most practical hope of delivering improved nutrition to the nation and world.

- Big problems to be solved. Very high requirements for quality, which translates into very high inputs of pesticides, water and fertilizer with the associated production costs and risks of food residues and environmental impact.

- Great genetic opportunities. A narrow genetic base in US cultivars compared to the genetic breadth in exotics forms. More exotic germplasm is available than for any other major crop. Almost all modern varieties have exotic germplasm in their pedigrees. Exotic forms that are more amenable to introgression than any other major crop, including recent first-time demonstration of potential in the biotech transfer of wild relatives' genes to cultivars. Past demonstrations that exotic germplasm can make important contributions in terms of specific traits, general heterosis, and opportunity for more efficient breeding methods. Past investments in this crop's germplasm have now built the world's premier collection of stocks and infrastructure within the US.

- Great potential for economic impact. Among the greatest potential for market expansion. Very high potential value-added profit in processed forms. Great differential between average and demonstrated optimum yield. Among the greatest diversity of cultivation in countries, latitudes and altitudes.

- Finesse needed. Germplasm maintenance requires special knowledge, technology and facilities for seed and clonal preservation, exclusion of systemic diseases, and prevention of genetic erosion in seed populations.

ALL OF THESE POINTS ARE TRUE OF POTATO.

B. RATIONALE FOR NRSP-6:

B. 1. Priority Established by ESCOP (Science Roadmap)

Challenge 1. *We can develop new and more competitive crop products and new uses for diverse crops and novel plant species.* This is the heart of what NRSP-6 aims to promote. Genetic diversity of the exotics at NRSP-6 represents the potential diversity of improvements in productivity, quality and resource use efficiency realized in new cultivars.

Challenge 3 . *We can lessen the risks of local and global climatic change on food, fiber, and fuel production.* Potato is cultivated across a broader range of latitudes than any other major crop. Thus, the effects of climate change could be different in different growing regions, and require the screening for multiple new traits in exotic germplasm which can be incorporated into the crop. Potatoes also exist in nature in a great diversity of ecological niches, so the impact of climate change on in situ genetic diversity may be variable and call for especially close monitoring of how diversity in the genebank represents that which exists in nature. For example, changes in natural selection pressures may also implicate the need for recollecting done by genebank staff.

Challenge 4 . *We can provide the information and knowledge needed to further improve environmental stewardship.* As already mentioned, the heart of what NRSP-6 aims to promote is genetic improvement. Research supported by NRSP-6 will continue to find ways to make a crop that is more efficient at using fertilizer and water inputs and can naturally resist pests and diseases. That means less use of pesticides and fuel.

Challenge 5 . *We can improve the economic return to agricultural producers.* This can be achieved through lower input costs keeping all other factors steady. Or, quality can improve to support higher prices at the same market share. Or, yield can improve with expansion of both potato's unit value and market share so current prices are not depressed due to overproduction. The utopian scheme for the potato crop is to use germplasm to make gains in all three areas: less input costs, higher yield per area of land, and higher quality. Other initiatives that will contribute to these general goals are increasing *net* yield by reducing storage losses, capitalizing on virtual demand by removing the physiological limits to potato production due to the climate and other factors (disease, e.g.) in a certain growing region

Challenge 6 . *We can strengthen our communities and families.* NRSP-6 can have an impact on poor small farmers in developing countries who could improve their standard of living and maintain their culture because germplasm inputs gave them a more marketable and nutritious crop (by increasing frost tolerance for high altitude farmers, for example). Food security in developing countries often has a favorable influence on political stability, which reduces the money US citizens must spend to maintain military clout and foreign aid. Good health is a basic factor in the productivity and well-being of all communities and families. Health is positive in itself, but a healthy populace can also have a higher standard of living due to more productivity and less need to spend the profits from that productivity on insurance, medical care and government intervention programs

Challenge 7. *We can ensure improved food safety and health through agricultural and food systems.* Three points here: 1) Improved potato has outstanding potential to have a significant health and nutrition impact on a population basis because it *already has a regular, high level of consumption* across all demographic categories in the US. Compare, for example, to blueberries which have famous levels of antioxidants per serving, but are very expensive and current consumer preference is such that they are eaten only in small quantities and irregularly. 2). Potato has had obvious appeal—it's cheap, good-tasting in many forms, and filling. But since it is not leafy-green, its known and potential contributions to health have not been emphasized. With potato becoming almost the "poster child" for the lifestyle change of 25M US citizens now significantly avoiding high-carb/glycemic foods, we need to identify and quantify, for example, potato antioxidant and anti-cancer compounds that will be eliminated in the US diet, and their likely impact. 3) Because about 1.3M acres of potato are cultivated in the US and 48M worldwide, reducing the need for chemical inputs in the potato crop through genetic means could significantly reduce the exposure at all levels at which agrichemical use now poses a health risk (manufacture, transport, storage, grower, consumer). The Environmental Working Group reports potato as being among the "dirty dozen" of fruits and vegetables containing pesticide residues, in fact, having the highest average ppm of any of the items tested (http://www.foodnews.org/reportcard.php on May 4th 2004). This is a striking expression of the need to continue NRSP-6 service so genetic alternatives to pesticides can be found and deployed. [See Appendices 3 and 5 for specific service activities that are promoting use of NRSP-6 germplasm and thereby a more productive, versatile, profitable, nutritious and environmentally safe potato crop]

B. 2. Relevance to stakeholders:

NRSP-6 stakeholders are researchers, breeders and those who use their product (i.e., producers). Here are the reasons why there is a continued need and relevance of NRSP-6 service to stakeholders, and why US scientists (and foreign ones, for that matter) will depend on NRSP-6 germplasm more, not less in the future:

1) No other public or private programs have come forward as being willing or able to provide the unique services of NRSP-6. Fifty years of public support of this genebank has resulted in the world's premier collection of over 5,000 items of germplasm for the world's most important non-cereal crop. At least 40% of these are unique. Failure to acknowledge a continued need for NRSP-6 presumably would call for discarding this germplasm or entrusting it multiple state and private programs with no centralized government oversight. Neither choice would be consistent with the best interests of US agriculture, or historic US germplasm policy.

2) The need for potato research and breeding is not declining. Development of technology has enhanced the quantity and impact of research and publications involving germplasm. There are more private breeders, more seedlings grown for yearly selection, more sophisticated facets of evaluation, and more varieties being released. The onus to gather, format and distribute information efficiently has greatly increased because communication and data management technology has made it possible. There is a growing need for adapted varieties in rapidly expanding production areas like Asia. World demand is nowhere near saturation, since there are huge population centers with only a fraction of the per capita consumption potential demonstrated in the US and Europe. Similarly, world yield index is still far below the potential demonstrated in areas where genetics are finely tuned to growing conditions (average yields in India and China are less than half of that in US), showing that there is still a great deal NRSP-6 germplasm can contribute.

3) Acquisition of germplasm from foreign genebanks or directly from the wild is getting even less practical for US researchers. Other genebanks have faced financial problems or reorganization which have reduced their capacity to maintain availability of germplasm and services. Countries with native potato germplasm to share are doing so less freely due to policies reflecting feelings of national ownership and problematic expectations of “benefit sharing” that have delayed access indefinitely.

4) Despite advances in quarantine testing technology and organization, access to imported germplasm will continue to be delayed by one or two years. And if we want to avoid the wasted time and expense of having quarantine repeatedly process the same material for multiple importers, we need the coordination, information and preservation provided by a genebank.

5) Pressure to reduce agrichemical inputs that may threaten the health of humans and the environment has increased, making genetic solutions through germplasm even more urgent.

6) Physiological constraints such as a need for cold tolerance (applied especially to the mountain growing regions like the Andes but everywhere subject to the global cycle of wider weather fluctuations), heat and CO_2 (global warming), water and fertilizer use efficiency (loss of Klamath basin water rights, phosphates in lakes, nitrates in groundwater, energy costs for pumping water and making fertilizer) have increased, as well as a general need to increase the adapted range of potato to production areas where it would benefit the world economy.

7) Technology has increased the possibilities for germplasm use making it more valuable. The prospects of easily identifying and mining genes from exotic germplasm (reducing the long and expensive process of conventional breeding) makes the service of NRSP-6 even more valuable. Even if GMO’s are banned, consider this one example: We are just opening the door of genomics that will make it possible to tag genes in very weedy, uncrossable species and then very efficiently screen for those genes in germplasm that can be easily used for conventional breeding. This application of biotech to more efficient screening has enormous potential.

THESE FACTORS SHOW THE HIGH AND RAPIDLY INCREASING OPPORTUNITY COSTS OF DECIDING TO REDUCE INVESTMENT IN NRSP-6 SERVICE.

C. IMPLEMENTATION:

C. 1. Management, Budget and Business Plan.

C. 1. a.i. PLAN for future activities.

Acquire germplasm. We need to continue to put effort into collecting in Latin America, notably Peru, before native populations are lost to habitat degradation and while local collectors who have first hand knowledge of their locations are still working. We should continue the convenient and inexpensive collecting effort in the USA for the sake of preserving that germplasm and using it as models for genebank studies to identify factors that affect the status and dynamics of genetic diversity in the genebank and the wild. We need to continue to be aware of worldwide developments in germplasm opportunities, and anticipate the needs of US breeders by requesting useful stocks from other ex situ sources.

Classify germplasm. The ARS taxonomist will continue to assign species names to all items in the genebank and do the research and evaluation work necessary to make the classification system more stable and useful as a predictor of the germplasm's traits. He will continue and extend work to elucidate the systematic relationships of domesticated potato and its wild relatives.

Preserve germplasm. With the collection at 4600 active populations and growing, we need to be increasing seedlots at the rate of 150-200 per year for a 25-30 year cycle. We need to direct resources to keep pace, and promote research that will provide the knowledge and technology needed to increase efficiency of seed production while keeping the maximum genetic diversity. We need to continue to direct resources toward maintenance of the clonal tissue culture stocks. Potato cultivars and other special selections are propagated clonally, and are subject to systemic viruses that must not be allowed to contaminate production or breeding programs. Botanical seeds are also subject to (notably) PSTV, a highly infectious viroid that cannot be cured. NRSP-6 must not be a source of diseased germplasm, so will continue putting time and resources toward keeping stocks disease-free and doing the testing to confirm them as such.

Keep records for management and outreach. We need to continue to invest the resources to keep internal records that help us efficiently manage the genebank, and have accurate, up to date data to share with germplasm users (via GRIN, for example).

Evaluate germplasm. We need to direct resources toward broad and basic evaluation for traits not currently in the mainstream of research. Our goal should be to have a comprehensive outlook on potato germplasm, notice or envision new traits or new sources with economic potential, conduct a preliminary screen and characterization, and announce the discovery to the research community in the form of on-line databases and scientific publications. The subjects of past evaluation will continue. In addition, we intend to expand efforts to prospect for traits with direct consumer impact like nutritional, anti-oxidant and anti-cancer factors. We must be generalists with the common denominator or germplasm so be shrewd about which evaluation projects to choose and how far to take them. Some evaluations pertaining directly to potato germplasm (like seed germination studies) will be best done in-house. But we are convinced that it will usually be much more efficient to partner with programs outside the genebank that have expertise and facilities already in place. This approach has the added benefit of keeping us in tune with the needs of scientists in the respective Regions.

Manage personnel and resources. We will: Manage staff time and budget to maximize efficiency and flexibility. The emphasis on this is tied to the reality that personnel costs represent the biggest category in the budget. Strive to make prudent decisions on what we should do in-house and what should be hired or purchased. Hold weekly group meetings to make sure the team is working together cooperatively, safely, and respective strengths are matched to the tasks at hand. Conduct annual self-review of overall project progress each year with local staff, and individual staff performance evaluations. Hold TAC meeting on site every other year to report, tour facilities, provide "face time" with all local staff, and solicit management input from national experts. Each year prepare CSREES Annual Report, UW Hort Department

Professional Activity Report, and ARS Performance Plan Appraisal, as ways to invite feedback on methods, focus and management.

Deliver germplasm and services. We need to continue the rapid delivery of high quality germplasm and information. To meet that goal, we will continue the mindset of considering ourselves a business that needs to vigorously compete for the customer's order, and consider his research success to be *ours* too. But maximum service goes far beyond delivering the particular stocks a customer requests. We need to also be able to advise on selection of research germplasm, and the most appropriate form and techniques by which to study or hybridize it. To do this, we will need to continue to invest time in keeping "in touch" by being involved in the science, studying the literature, training students, participating in professional societies and collaborating with many state and federal potato researchers in the US, and with our counterparts in potato genebanks abroad.

C. 1. a.ii. PLAN for resource inputs (see budget information pages for figures)

1. Human resource inputs. The plan to accomplish the above will include national administration through a Technical Committee, and local administration by the ARS Project Leader, Taxonomist and Research Leader. Taxonomist and Research Leader will be stationed at UW-Madison, and Project Leader at Sturgeon Bay (see Appendix E).

2. ARS inputs. Associated base research budgets from ARS scientists and various sources of outside grant funds obtained by these individuals also support technical research, labor, supplies and equipment that directly enhance NRSP-6 service. ARS Project Leader and Taxonomist are officially designated at 80% and 40% appointment to NRSP-6, respectively. However, the creation of those positions in ARS was primarily motivated by a need to support the genebank with taxonomic and genetic leadership and expertise, and their work is 100% involved with the interests of NRSP-6 germplasm. The same is true of the Germplasm Enhancement Geneticist at Madison involved exclusively in research aimed at prebreeding with NRSP-6 germplasm. Although this position has no formal appointment to NRSP-6, it has a byproduct of generating evaluation data for economic traits and discovering how to make introgression more efficient. All activities by these three programs involve making potato germplasm better understood and more easily used, so all of the resources they expend can be considered a contribution to NRSP-6. In addition, two other positions in the USDA,ARS Vegetable Crop Research Unit are partially involved in studying and breeding the genebank stocks: a Late Blight Plant Pathologist and Post harvest Storage Physiologist. ARS administration costs at the Midwest Area and National Levels are also significant. ARS also provides data management services through GRIN, and a yearly evaluation grant administered by the Crop Germplasm Committee, of which Project Leader is chairman (see Budget Tables 5-7).

3. University of Wisconsin inputs. The University of Wisconsin Department of Horticulture (HORT) will provide lab and office space for on-campus research that directly supports the NRSP-6 service, with administrative and secretarial support for Madison personnel provided jointly by ARS and HORT. The University of Wisconsin Peninsula Agricultural Research Station at Sturgeon Bay (PARS) will continue to be the headquarters of NRSP-6. PARS will contribute much of the needed facilities and associated resources: 10 greenhouses, 5 large

screenhouses, office and storage buildings, two labs, field plots, travel and farm vehicles, security and maintenance, utilities (including the major input of heat and light for greenhouses), plus some secretarial service. HORT also provides administration of personnel for local state employees and graduate students under the supervision of the ARS personnel. UW provides accounting services for the NRSP-6 budget.

4. Grants and Collaborator inputs. ARS scientists will continue to get grants and engage numerous state, federal and international collaborators who contribute expertise, facilities, equipment and funds to joint projects. Project Leader will continue as chairman of the Crop Germplasm Committee, which provides $15-18K in germplasm evaluation funds each year.

5. No fees for service. Charging fees for services has been suggested several times in the past, but always determined to be impractical and counterproductive because: 1) implementation would be costly and complicated, 2) it would depress germplasm distribution and use, and 3) it would contradict US policy of free exchange and perhaps inhibit donations of germplasm to NRSP-6.

6. CSREES – SAES input. NRSP-6 is the NPGS working genebank for the nation's top vegetable, so is perpetual in nature and national in scope. It would be problematic to effectively support such a project wholly with multiple short-term grants or other soft sources.

For over 50 years, the two important elements of funding and administration for NRSP-6 have developed as a partnership of SAES, USDA/ARS, and UW. Continued significant funding and technical/administrative inputs on an interregional basis are seen as necessary to keep this partnership healthy so as to maintain the project's impact and efficiency.

The flat budgets of the past (at about $160K—Table 1), combined with necessary increases in the size and services of the project have already resulted in MRF supplying a reduced share of support over the project term, and reduced discretionary funds (Table 2).

For MRF resources to cut back to funding only the most core service components of the project (positioned staff salaries, TAC travel, supplies and services most closely tied to preservation, validation, documentation and distribution of germplasm), we estimate the basic need would be about $175K in 2004 dollars (Table 3), or $190+K over the FY2006-10 term (Table 4), anticipating modest inflation. This does not include the historic NRSP-6 efforts related to research (genebank-oriented technical research, graduate student salary and supplies, supplies and equipment shared by NRSP-6 service and ARS research efforts) and would not include 100% FTE salary for the two positions currently filled by staff working at 75% and 80%. The above demonstrates how even a reduced share of inputs by MRF would need a 20% increase in OTT funding for the FY06-10 project.

Regardless, we understand that a mandate to reduce overall OTT funding and/or make it more flexible means NRSP project renewals generally must propose smaller budgets. Thus, we propose a reduction of 5% per year to 75% in the final (5th) project year.

7. Business plan for 25% reduction. **Plan:** The budget proposal above anticipates a progressive loss of about 8, 16, 24, 32, and 40 thousand dollars over the project term, or an

average of $24K per year. The most transparent and convenient way to shift the burden will be by deferring purchase of non-essential supplies, services, equipment and ad hoc labor or purchasing them with with alternate funds. But even if all other outlays are eliminated, the current staff cannot be maintained with a 5% annual reduction. So a reduction in FTE supported by MRF must occur in FY08. A high priority will be given to finding funding *mechanisms* that will allow core personnel to continue as UW employees to maintain host-state ownership and minimize disruption of the cohesion of the current staff. **Alternate sources:** Various possibilitiies for recovering a reduction in OTT funds were discussed at the joint TAC and CSREES Review meetings held in late June 2004. These included a regional or interregional project funded by a consortium of "potato" states, additional inputs from ARS, or a CSREES Special Grant. Pursuit of outside competitive grants and unfunded synergistic collaborations that boost the project's impact will be continued. It is difficult to be more specific about the sources and relative significance of alternate funding sources at this time.

C. 1. b. Critical assessment of past accomplishments: Review of past productivity, completion of original objectives and the relationship between projected goals and actual accomplishments. Copied below are the abbreviated Objectives and Procedures proposed in the past project term. Accomplishments noted in [ ]. See Appendices 1-6 for further details and Appendix 7 for CSREES Review report.

<u>Acquire germplasm to expand genetic diversity contained in the US Solanum germplasm collection</u>**.** *Solanum* species will be collected in Latin America each year according to priorities set by NRSP-6 [Peru - 158, US - 56, Honduras & Panama – 5. Major collecting planned in Peru thwarted for reasons beyond our control]. Germplasm of interest will be requested from CIP, BGRC, and other potato genebanks based on the new global evaluation database [207 new clonal stocks incorporated, got LB stocks from BGRC, got 105 rescue stocks from VIR via Poland]. ARS releases will be incorporated into the NPGS collection [NSSL was designated as repository for these]. Documentation of all new introductions will be computerized and entered into the national germplasm database, the Germplasm Resources Information Network (GRIN), local databases, and the Intergenebank Potato Database [done].

<u>Classify accessions with species names which will serve as stable identifiers, and promote efficient utilization</u>. Species names will be assigned to all new accessions [done]. Taxonomic studies using both molecular and classical techniques will be employed to determine stable species boundaries [done-- see Spooner CV]. The herbarium will be updated to include new collections, labels will be printed and affixed where missing, and a catalog listing available herbarium specimens will be printed and distributed [Available on Internet instead of print, duplicate samples of each species now also deposited in National Arboretum herbarium].

<u>Preserve all NRSP-6 germplasm in secure, disease free, and readily available form according to best current technology and conduct research pursuant to improving that technology</u>. Research to identify less expensive, easier, and more reliable ways to grow and increase potato germplasm will continue [e.g., tentative detection of apomixis]. We will research the potential of remote growouts [done successfully for late blight screening, tested field tuberization in FL, TX, HI, NC], straw mulch for weed control [markedly reduces hand weeding], improved potting media [identified and avoided media that depresses germ], treatments to improve uniformity of germination [evaluated heat pads, germination cabinet, in vitro germination, longer GA presoak,

predictivity of tetrazolium viability testing], pollination techniques [tested and incorporated use of bee sticks for difficult crosses, continuous fertilization for better flowering, technique for raising plants above soil to prevent tuberization and enhance flower retention]. Samples of new germplasm will be transferred to NSSL and/or the University of Wisconsin for backup [done-- virtually all seed accessions that can be deposited in NSSL are now there]. Rigorous disease prevention and monitoring practices (mainly for viruses) will be continued [4674 PSTV tests done, in vitro collection maintained]. These are important because the potato crop and clonal gemplasm is vegetatively propagated and these systemic viruses can contaminate breeding and research programs, cause seed production fields to be rejected, and disqualify the crop for foreign export. We will add bacterial ring rot screening to the health monitoring protocol for the in vitro collection [done], and will experiment with modified atmospheres to improve long term in vitro storage [not done]. What is the best genetic sample of diversity for each species, and how do we most efficiently collect and maintain it? We will pursue lab equipment and staff for molecular marker analysis to quantify genetic relationships within species [started on site and expanded capacity in Madison. See Appendix 2 for specific accomplishments in this area]. Research into the *in situ* status of US germplasm will be done as groundwork, and an *in situ* preservation project will be started in the Southwest US [surveyed and collected populations from the southwest USA each year 1992-2003].

<u>Distribute germplasm, associated data and advice to all researchers and breeders in a timely, efficient, and impartial manner</u>. Quick and impartial distribution of germplasm will be maintained. [55,390 units distributed, = 44,475 seed packets, 8,443 in vitro tubes, 3,766 tuber families, and 368 herbarium specimens to 291 cooperators from 36 different states and 35 different countries]. An updated catalog of available stocks will be prepared, printed, and distributed to cooperators [now all on-line].

<u>Evaluate the collection for as many important traits as possible</u>. Unpublished screening data of experiments conducted by cooperators will be requested, and published reports will be reviewed to gather evaluation information [done by Spooner under CGC grant 2002]. Data will be summarized, compiled with previous information, and made available in GRIN, local databases, published research papers and printed catalogs [done. Catalogs now on Internet because print form is obsolete]. We need to do more systematic screening for economic traits, their genetic characterization, and the identification of specific individuals and/or populations which are best candidates for enhancement [began or continued projects on Late blight, cold tolerance, tuber calcium, root mass, antioxidants, glycoalkaloids, hormone mutants, tumor inhibition, resistance to Jelly end disease-- see Appendix 3 for details].

<u>Collaborate with foreign potato genebanks for global database development, exchange of materials and technology, and free access of germplasm</u>. Intergenebank collaboration initiated in 1990 will be continued and expanded to aid NRSP-6 in meeting its goals. It is essential that the US continue active cooperation with other world genebanks for the most efficient collection and preservation of potato genetic resources, and for building international relations which will insure future access to native germplasm in Latin America. [e.g., published global potato database on the web, joint research conducted on parity of reputed duplicate collections at CIP and VIR and sources of nematode resistance with VIR, hosted VIR colleague at 1999 and 2000 Potato Assn Meetings, led APIC meetings at European Potato Assn in Germany 2003 and at Latin American Potato Assn in Chile 2004—see also Appendices 1 and 5]. World potato

genebanks have overlapping technical challenges, collections, and customers, so NRSP-6 is also a key support and backup for these genebanks.

C. 2. Objectives and Projected outcomes.

C. 2.a. Objectives, milestones and deliverables. Seek and introduce valuable stocks, preserve them in the most effective manner (maintaining maximum genetic diversity and a sufficient quantity of propagules such that nearly 100% of the collection is available for distribution), evaluate them for useful traits, document them and manage records so that germplasm users are aware of this resource and deliver vigorous, healthy stocks to users according to their needs. Follow plan detailed in section C.1.a.i. above

C. 2.b. Assessment of Productivity. Section 4 following details how we have produced and measured impact in the past and how we intend to build on that productivity in the future. See also Appendix 6.

3. INTEGRATION:

The close working relationship and involvement of the major participants (ARS, PARS, UW) has already been described. In brief: The Project leadership is composed of ARS employees who must interact with ARS administration and be subject to performance evaluation related to NRSP-6 service appointments. ARS administration is part of the NRSP-6 TAC. PARS provides the physical location of NRSP-6, and coordination between the objectives of the two programs takes place on a daily basis. Most of the local NRSP-6 staff are UW employees. The ARS staff are full professors in the UW Department of Horticulture, have departmental lab and office space, and supervise graduate students who work on potato germplasm projects. ARS staff share equipment and participate in cooperative research with their state HORT peers. Thus, the very strong UW HORT potato research program is fully engaged in NRSP-6 project activities pursuant to the enhancement of NRSP-6 service. NRSP-6 has led the effort to coordinate the activities of world genebanks through the Association of Potato Intergenebank Collaborators (APIC). NRSP-6 is a fully-engaged member of the National Plant Germplasm System. Staff attend all meetings of the advisory committee for genebank directors (PGOC) and the committee for the national germplasm management database (GRIN). NRSP-6 staff are fully engaged in state potato programs. We participate in scientific, grower meetings, and fields days and conduct collaborative research with a view to better understanding the needs of the industry and getting input regarding how NRSP-6 can meet them [see Appendix 5 for details including new partnerships and their positive impact on stakeholders].

4. OUTREACH, COMMUNICATIONS AND ASSESSMENT:

4. a. Plan (continue and expand the following initiatives)

4.a.i. Audience and Visibility. The primary recipients of our service are breeders and the scientists doing research that supports breeding. We also serve researchers seeking to optimize germplasm management. Home gardeners and non-professional botanists are not turned away. We have a general educational outreach. For example, we provided free brochures to National Park and Monument visitors in AZ, NM, UT and CO, and routinely give tours, talks to public school classes and other groups, advice on germplasm use technology (e.g., on the web) or in personal correspondence associated with germplasm orders or cooperative research and evaluation projects.

We attract publicity in popular media and communicate to scientists through published scientific research papers involving NRSP-6 germplasm. Create, maintain and distribute brochures. Make collaborative partnerships with high-profile national and international potato experts. Contribute to scientific meetings. Serve in leadership roles in potato research associations and journals. Establish an email group and website with which to keep in regular contact with germplasm users. Participate fully with GRIN. Pursue global outreach and awareness of NRSP-6 through involvement in the Association of Potato Intergenebank Collaborators (APIC). Give tours and talks to professional and non-professional visitors or groups and present posters at meetings. Maintain association with strong reputation of Department of Horticulture, UW-Madison. [See Appendix 1. for details of accomplishments and plan for promoting visibility of the NRSP-6 service].

<u>4.a.ii. Engagement of stakeholders</u>. NRSP-6 established an email group and offer stocks and services 3-4 times per year. We will continue to ask Potato Assn of America Breeding and Genetics section members for suggestions on how to improve service each year. Regional Tech reps annually poll germplasm recipients about satisfaction with service. As CGC chair, Project Leader must survey germplasm evaluation needs. We correspond meaningfully with recipients of *each order* to make sure their needs were completely met, ask for suggestions or other ways we could improve service [see Appendix 5 for details].

<u>4.a.iii. Method to measure accomplishments and impacts</u>. The most important documented evidence with which to measure impact is **the advance of practical knowledge about germplasm** reflected by formal research publications using NRPS-6 stocks and the presence of exotic germplasm in pedigrees of new cultivar releases (**that practical knowledge transformed into a better crop**). These milestones of progress are the fruits NRSP-6 distributions of germplasm to the states and regions documented in Appendix 6. Informal, but much more specific and timely is the individual feedback from germplasm recipients who often confirm that their work could not have been accomplished without the materials and advice they were provided.

<u>4.a.iv. communication pieces</u>. Locally generated brochures, web pages, poster at meetings. The “Southwest Potato” brochure was a deliberate effort to connect germplasm with concepts the popular audience already understands and cares about (anthropology, ecology, food). Clearly, the ultimate audience and stakeholder is the individual taxpayer and voter. The danger of doing excellent, important work but not communicating it in terms the public can understand has not escaped us. But while we probably are in the best position to think of points that promote our work, it *takes a precious investment of time*. Staff are already working at capacity to fulfill the basic work of the Project because budgets are tight. The most promising opportunities to address this problem are in the efficiency of the Internet, and being lucky enough to be invited to tell our story in widely distributed popular outlets like Agricultural Research magazine and various grower magazines.

4.a.v. mechanisms for distribution of the results. Annual Report, notes of accomplishments and plans in preliminary pages of annual Budget Requests, and TAC meeting minutes are on the web. Technical, administrative, and other ad hoc advisors also receive a one-page monthly report composed of 10-12 bullets of news or accomplishment so that they can have current information about the course of the project, make suggestions and ask questions. Otherwise, IR-1/NRSP-6 has always had the philosophy that the best and only way to catch the attention of germplasm users, communicate effectively with them, and understand their needs is to become their peers by being germplasm users ourselves and vigorously participating in all aspects of the science. Example: Our work with tuber calcium and the example of CSREES/ARS/University cooperation in practical application of germplasm was reported in Agricultural Research Magazine, Business Week and other popular publications read by a broad professional and popular audience. The value of our work in developing gibberellin deficiency mutants was specifically mentioned in three of the four invited talks for the plenary symposium at the 2003 Potato Assn of America meeting: “Recent advances in the physiology of tuberization and dormancy”.

4. b. Past successes (see Appendices 1, 5 and 6 for full details. Appendix 7 is CSREES Review Team’s report of on-site review held June 30-July 2, 2004).

Appendix E: PROJECT PARTICIPATION:
Current example of NRSP-6 Structure

1. COOPERATIVE AGENCIES AND PRINCIPAL LEADERS

State Agricultural Experimental Stations		**Representative**
Southern Region		J. C. Miller, Jr.
Western Region		A. R. Mosley
North Central Region	Vice Chair (2004)	D. S. Douches
Northeastern Region	Secretary (2004)	W. De Jong

United States Department of Agriculture

Agricultural Research Service		
Technical Representative	Chairman (2004)	C. R. Brown
National Program Staff		P. K. Bretting
Area Director, Midwest Area		A. D. Hewings
Cooperative States Research Education & Extension Service		A. M. Thro
Animal and Plant Health Inspection Service		L. E. Levy
Inter-Regional Potato Introduction Project	Project Leader	J. B. Bamberg

Agriculture Canada — T. R. Tarn

Administrative Advisors

Southern Region		R. L. Westerman
Western Region		C. Y. Hu
North Central Region	Lead	S. A. Slack
Northeastern Region		S. D. Reiling

Also: Input from Peninsula Agricultural Research Station (PARS) host, UW-Dept of Horticulture, evaluation collaborators and germplasm users from all Regions. See budget Table 6 and Appendices for other collaborators.

Budget Tables: History, status and proposal

The numbers in the following tables demonstrate and quantify these concepts:

1. The 18 year history of MRF inputs is equivalent to 1.4% constant increase. This represents loss to inflation not considering increasing size and outreach of the Project.

2. Using the average budget from the past term of $160K, we have had a serious loss of discretionary dollars due to salary increases and general inflation.

3. The current (FY 2004) estimated MRF need is about $175K. This incorporates cutbacks in the CSREES share of the burden to only the most basic core services (2.4 FTE of permanent staff, no Grad student, minimum seasonal labor, supplies and travel, no capital improvements).

4. If $175K in 2004 dollars, and we project 3% inflation (including everything-- salaries, fringe, inflation, expansion of size of the collection and its service), the average 5 year need for 2006-2010 would be $197K. Each year in the past Project term, TAC has recommended 3% budget proposal increase as appropriate alternative to complete capitulation to inflation.

5. Considering only the most obvious and objective inputs from UW-HORT, PARS, ARS-VCRU, and ARS-NPGS in funds and personnel, the proposed contribution of MRF will support less than 15% of the costs of running NRSP-6 service under the proposed cut-back in MRF responsibility for FY06-10.

6. Average yearly ARS Project Leader contribution to state and international partnerships was about 60% of MRF inputs ($95K), and estimated matching collaborator in-house contributions (including every region) added another 15% ($31K) for a total extramural contribution of about 75% of MRF input per year.

7. ARS Staff got grants from various sources for a total of about $219K per year, or about 136% match of MRF contribution..

8. New FY 06-10 budget proposal incorporates attrition to 75% current (FY 2004) funding in FY10.

Budget Table 1. MRF contributions for past 18 years

18 year budget history

FY	Actual budget	Constant +1.383665% budget	Deviation from Constant
1987	134,651	134,651	0
1988	132,251	136,514	-4,263
1989	138,200	138,403	-203
1990	144,990	140,318	4,672
1991	142,014	142,260	-246
1992	147,552	144,228	3,324
1993	151,241	146,224	5,017
1994	153,498	148,247	5,251
1995	153,590	150,298	3,292
1996	151,196	152,378	-1,182
1997	160,405	154,486	5,919
1998	151,196	156,624	-5,428
1999	161,931	158,791	3,140
2000	161,931	160,988	943
2001	161,575	163,215	-1,640
2002	161,575	165,474	-3,899
2003	161,575	167,763	-6,188
2004	161,575	170,085	-8,510
Total 1987-2004	2,730,946	2,730,946	0

Budget Table 2. Loss of spending power due to increased fixed costs

ATTRITION IN SPENDING POWER

based on average budget of $160K

Year	salaries & fringe[1]	disc	% disc	disc in 1997 $
1997	108	52	33	52
1998	113	47	29	46
1999	115	45	28	43
2000	119	41	26	38
2001	126	34	21	31
2002	129	31	19	28
2003	137	23	14	20
2004	142	18	11	15

Sal and fringe averaged 3.8% increases per year
Lost an average of 9.4% discretionary $ per year
[1] Tech1 is 75% FTE, Proj Asst is 80% FTE, and no Grad Student
with full staffing disc funds would be < 0.

Budget Table 3. Current (FY 2004) conservative need

CURRENT MINIMUM NEEDS WITH NO GRAD STUDENT OR CAPITAL ITEMS

PERMANENT STAFF SALARIES & FRINGE[1]	$ biweekly	$ monthly	$ annual	% fringe	Total 1000$
Gardener CF at 100% (20% paid by MRF)	237		6162	45	9
Tech1 SS at 75%	694		18044	45	26
Proj Asst MM 80% (58% paid by MRF)		2427	29124	33.5	39
Tech2 AdR at 100%		3388	40656	33.5	54
					128
GRAD STUDENT					0
Extra and seasonal labor					
2 part time at 1000 hrs x $10 with 18% fringe					24
SUPPLIES, SERVICES and MAINT					
$1400 per month					17
TRAVEL (Proj Asst and TAC)					6
CAPITAL ITEMS					0
			TOTAL		175

[1] Appointment total is only 2.4 FTE

Budget Table 4. $175K needed in FY2004 projected over five future FYs

Current need projected over 5 years of inflation in $1000s

Year	2004 value Needed	Expected annual increase[1] 2%	3%	4%	5%
2004	175	175	175	175	175
2005	175	179	180	182	184
2006	175	182	186	189	193
2007	175	186	191	197	203
2008	175	189	197	205	213
2009	175	193	203	213	223
2010	175	197	209	221	235
5 FY Total	875	947	986	1025	1066
average for 2006-2010 =		189	197	205	213

[1] Annual inflation of salaries, fringe and prices (with no real growth in spending power) or in combination with needed expansion of work and services

Budget Table 5. MRF part of total contributions.

OTHER CONTRIBUTIONS SUPPORTING NRSP-6 SERVICE

SOURCE OF INPUTS		Value in 2004	Expected Ave Annual value at 3% infl for 2006-2010	ADDITIONAL NOTES
UW-Madison[1]				
	NRSP-6 Personnel salaries	64	72	See NRSP-6 budget requests
UW-PARS (Sturgeon Bay)				See NRSP-6 budget requests
	Secretarial	10	11	
	Utilities (UW physical plant budget)	60	68	Notably greenhouse heat and light
	Infrastucture, vehicles & equipment use	50	56	
ARS (VCRU in Madison and cooperating programs) -- % involved with NRSP-6 mission				
	Spooner (Collecting, taxonomy and herbarium)[2] -- "40%"	100	113	40% of $250K research budget attributed to NRSP-6 service
	Bamberg (Admin, Evaluation, Germplasm methods)[2] -- "80%"	200	225	80% of $250K research budget attributed to NRSP-6 service
NPGS (Beltsville HQ)				
	Potato CGC evaluation grants	15	17	Bamberg is Chairman of committee
	GRIN data management services	40	45	One of 25 sites served by a $1.6M budget
Other Grants of PIs		219	246	See budget Table 7.
TOTAL OTHER		758	853	
CSREES MFR		162	138	Proposed 5% yearly reduction averages 85% of FY04 = $138K
%MRF		18	14	

(see next page for footnotes)

[1] Does not include **UW Contributions** of personnel and budget admin, secretarial, UW-Madison HORT bldg space and equipment use

[2] Although these positions have partial appointments to NRSP-6, **100% of effort contributes to the NRSP-6 service mission.** ARS created these positions expressly to support the genebank. Appointment percent is applied to entire ARS budget, not just salary outlay, because to do the latter (as has been our convention in past budget requests) makes the very unrealistic implication that all supplies, services, travel, and labor expendatures to cover these service appointments come from MRF.

Does not include inputs from budget of ARS **Potato Germplasm Enhancement position** (vice-Hanneman) at Madison originally created expressly to support the genebank with 100% of effort in putting the raw NRSP-6 germplasm in a form more easily used by breeders.

Does not include any inputs from ARS **Late Blight Pathology position** at Madison (vice-Helgeson).

Does not include any inputs from new **ARS Postharvest Physiology position** at Madison.

Does not include administrative input from **ARS Research Leader** (Simon) or costs of personnel, budget and program admin from ARS at Area or National levels.

Does not include contributions of the above ARS PIs' State, Federal and International **Collaborators** in projects that directly support the mission of NRSP-6 (see Table 6)

Budget Table 6. Project Leader's ARS inputs for evaluation with State and international collaborators for direct promotion of NRSP-6 service mission (in $1,000s)

YEAR	Palta & HORT (frost, calcium, etc.)[NCR]	Love (glycoalkaloids)[WR]	Miller (anti-oxidants)[SR]	Fry (late blight)[NER]	Ng (late blight)[Canada]	Kiru (nematodes & APIC) [Russia]	Carling (Rhizoctonina) [WR]	Drawe (field tuberization and calcium) [SR	Stevenson (late blight) [NCR]	Barak (roots) [NCR]	Phlak (anti-oxidants) [NCR]	Radcliffe (insects) [NCR]	Rosen (nitrogen and roots) [NCR]	Yencho (field tuberization) [SR]	Keyser (field tuberization) [WR]	Charlton (frost) [WR]	TOTAL
1997	12			3	4	3	6			10		4	15				57
1998	22			3	4		12	2									43
1999	25	4		3	4			2	12								50
2000	35			9	5			2	9								60
2001	93	8	10			5					13						129
2002	110	8	10														128
2003	177	8	10											2		2	199
continuing 2004?	x	x	x			x		x						x	x	x	
Total	474	28	30	18	17	8	18	6	21	10	13	4	15	2	0	2	666

Average cooperative ARS contribution = $95K per year
Conservative estimate of cooperator contributions at 1/3 = $31K per year
Total extramural cooperative support of NRSP-6 evaluation about $126 per year

Budget Table 7. ARS Staff's Grants used for projects that directly contributed to NRSP-6 service mission

Spooner Grants Summary (see CV for details)

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
Total: $73K

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

Bamberg Grants Summary

Collecting
nematode resistance in SW USDA/NPGS 2002 $3K
Total: $3K

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

GRAND TOTAL = $1.53 M

Yearly average ca. $219K

Budget Table 8a. NRSP BUDGET REQUESTS SUMMARY -- RENEWAL for FY06-10[1]

NRSP-6 Inter-Regional Potato Introduction Project FY06-10										
MRF FUNDING										
DESCRIPTION	Proposed FY06 (year 1)		Proposed FY07 (year 2)		Proposed FY08 (year 3)		Proposed FY09 (year 4)		Proposed FY10 (year 5)	
	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE
SALARIES	101.9	2.4	105.5	2.4	88.4	1.7	91.5	1.7	94.7	1.7
FRINGE BENEFITS	35.8		36.1		27.5		27.8		28.1	
WAGES	14.2		3.8		21.4		10.0			
TRAVEL										
SUPPLIES										
MAINTENANCE										
EQUIPMENT/ CAPITAL IMPROVEMENT										
TOTAL	**151.9**	2.4	**145.4**	2.4	**137.3**	1.7	**129.3**	1.7	**122.8**	1.7
Reduction from 162 =	**153.5**		**145.4**		**137.3**		**129.3**		**121.2**	
Percent reduction =	5%		10%		15%		20%		25%	

[1] **Note**: The budget plan shown here for 5% yearly reductions was the model recommended by the TAC / CSREES external review team that met in late June 2004. It acknowledges the mandate for reduced OTT funding for NRSPs, despite the team's conclusion that the quality of past work and future importance of NRSP-6 potato germplasm warrants *increased* funding.

Budget Table 8b. NRSP-6 PROPOSED OTHER SOURCES OF FUNDING (OSF) for FY06-10

OTHER SOURCES OF FUNDING

☐ Industry ☐ Federal Agencies ☐ Grants/Contracts ☐ AESs

☐ Other (please list): ____________

DESCRIPTION	Proposed FY06 (year 1)		Proposed FY07 (year 2)		Proposed FY08 (year 3)		Proposed FY09 (year 4)		Proposed FY10 (year 5)	
	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE
Sal & Fr by UW for NRSP	68.0	1.2	70.0	1.2	72.1	1.2	74.3	1.2	76.5	1.2
by PARS	15.0	0.2	15.5	0.2	15.9	0.2	16.4	0.2	16.9	0.2
by ARS for techs	60.0	1.2	61.8	1.2	63.7	1.2	65.6	1.2	67.5	1.2
by ARS for PIs	150.0	1.2	154.5	1.2	159.1	1.2	163.9	1.2	168.8	1.2
by ARS for GRIN	40.0	1.0	41.2	1.0	42.4	1.0	43.7	1.0	45.0	1.0
WAGES from ARS for techs	64.0	1.0	81.3	1.2	103.2	1.6	131.1	1.8	166.5	2.0
TRAVEL from ARS	20.0		20.6		21.2		21.9		22.5	
SUPPLIES	40.0		50.8		64.5		81.9		104.1	
MAINTENANCE	10.0		12.7		16.1		20.5		26.0	
EQUIPMENT/ CAPITAL IMPROVEMENT by UW	110.0		113.3		116.7		120.2		123.8	
Grants	230.0		236.9		244.0		251.3		258.9	
TOTAL	807.0	5.8	858.6	6.0	919.1	6.4	990.8	6.6	1076.5	6.8

	FY06	FY07	FY08	FY09	FY10	Total
MRF needed[1] (+3% per year)	186.0	191.6	197.3	203.2	209.3	
MRF proposed	151.9	145.4	137.3	129.3	122.8	
MRF shortfall	34.1	46.1	60.0	74.0	86.6	300.8
OSF increase[2]	34.1	51.6	60.5	71.7	85.8	303.6

[1] See BudgetTable 3 and 4

[2] MRF proposed to decline 5% per year plus inflation loss. Assuming 3% inflation as the baseline increases in all other outside funds, it is proposed ARS will increase support to genebank in wages, supplies and maintenance by an average of 20-25% per year to offset the total loss over the new project term and maintain the current level of productivity.

APPENDIX 1. Accomplishments that increase visibility and engage our professional and non-professional stakeholder audience with information about what NRSP-6 has to offer

1. J. Palta, coathor with Project Leader on 14 research publications, received Am. Soc. Horticuture Sci. (ASHS) "Researcher of the Year" award. 2003.

2. NRSP-6 Web page with contact info, links to GRIN, reports, technical tips, timely announcements of new services. 2004 (and continuous updates). http://www.ars-grin.gov/ars/MidWest/NR6/

3. NRSP-6 email group through which to advertise new stocks and services. 2002-.

4. Semi-popular brochure about NRSP-6. 2004. Martin, Max. (Editor). United States Potato Genebank. USPG publication, 4312 Hwy 42, Sturgeon Bay, WI, USA. Trifold.

5. Bookchapter review of potato germplasm conservation issues: 2004. Bamberg, J. B. and A. del Rio. Conservation of Genetic Resources. In: "Genetic improvement of Solanaceous crops, Vol.2: Potato" (Eds: M.K. Razdan and Autar K. Mattoo), Science Publishers, USA. 38 pp. [In press].

6. Comprehensive index and review of wild potato genetic resources collected and reported in North and Central America. 2004. Spooner, D.M., R. G. van den Berg, A. Rodríguez, J. Bamberg, R.J. Hijmans, and S.I. Lara-Cabrera. Wild potatoes (Solanum section Petota) of North and Central America. Syst. Bot. Monogr. Vol. 68. 209 pp.

7. Bamberg invited to participate in international potato research workshop organized by ARS. 2003. Beltsville.

8. Comprehensive review of wild potato genetic resources collected and reported in the southwest USA, emphasizing germplasm collection techniques (developed from yearly collecting expeditions by Project Leader & colleagues, 1992-2001). 2003. Bamberg, J. B., A. H. del Rio, Z. Huaman, S. Vega, M. Martin, A. Salas, J. Pavek, S. Kiru, C. Fernandez and D. M. Spooner. A decade of collecting and research on wild potatoes of the southwest USA. Am J. Potato Res 80:159-172.

9. Exhibit and represent NRSP-6 in presentations off campus: Present poster on NRSP-6 research at Latin Amer Potato Assn (ALAP)(del Rio 2004). NRSP-6 poster and presentations at Crop Science Soc. of Amer, Denver; Potato Assn Amer, Spokane; Green Bay Bot Gardens (2003 Martin). Invited NRSP-6 screening report presented at Late blight field day, Toluca, Mexico (2003 Bamberg). Presented poster on NRSP-6 at Chicago Botanic Garden symposium (2000 del Rio).

10. NRSP-6 work featured in popular media. Agricultural Research, Business Week, and Spudman magazines (2003), The Potato Grower and Agricultural Research magazines

(2002), Ruth Ozeki, novelist, visits genebank to gather information for her future book on potatoes (2001), Local newspaper feature (2000). The Grower and Diversity magazines, Public Television documentary “Natural Heritage Project” filmed at Chaco Canyon, NM (1999), The Potato Grower (1998)

11. Promote and organize meetings of Association of Potato Intergenebank Collaborators (APIC), a consortium of world potato genebanks. Valdivia, Chile (2004 del Rio), Hamburg, Germany (2002 del Rio), New Delhi, India (1999 Bamberg), Dundee, Scotland (1997 Bamberg). Exchange of research results, technical expertise, tour facilities and meet staff, plan joint databases and other projects.

12. Invited presentation in Korea on genebank methods research. 2001. Bamberg, J. B. and A. H. del Rio. 2001. Research and technology for efficient preservation and utilization of potato genetic resources. Potato Conference arranged by Haktae Lim, Korea, Nov. 13-18. (travel restrictions as a result of Sept-11 attack precluded my presenting the talk myself, but I prepared the text and slides and it was presented by Dr. Lim).

13. del Rio gives invited lecture at International Potato Center (CIP). Lima, Peru to participate in a workshop on the association of genetic and eco-geographic diversity in potato populations. 2001. Lima, Peru.

14. Bamberg invited to participate in CEEM/FAS late blight workshop in Poland. 2001. Warsaw.

15. History of the intergenebank (APIC) project to create a joint database and announcement of the resource on the Internet. 2000. Huaman, Z., R. Hoekstra, and J. Bamberg. The intergenebank potato database and the dimensions of available wild potato germplasm. Am. J. Potato Res. 77:353-362.

16. Popular brochure that relates potato germplasm issue to topics of public concern and made available for free distribution to visitors to national parks and monument interpretive centers in the southwest. 1999. Bamberg, J. B. Wild potatoes on public lands of the Southwest. US Potato Genebank publication, 4312 Hwy 42, Sturgeon Bay, WI, USA. (Trifold).

17. APIC-related Invited Presentation for the Plenary Symposium of Potato Assn of America Annual Meeting in New Jersey, Aug 1999. 1999. Bamberg, J., A. del Rio and Z. Huaman. Intergenebank Cooperation in Genetic Diversity Conservation Research.

18. APIC collaborator’s Invited Presentation for the Plenary Symposium of Potato Assn of America Annual Meeting in New Jersey, Aug 1999. 1999. Huaman, Z., R. Hoekstra, and J. Bamberg. History of APIC and the initiative to create comprehensive databases.

19. APIC-related Invited Presentation at the Global Conference on Potato, New Delhi, India, Dec 1999. Bamberg, J., A. H. del Rio & Z. Huaman. 1999. Intergenebank Cooperation in Genetic Diversity Conservation Research.

20. Invited lecture by Project Leader to UW Plant Pathology course students on NRSP-6 and general plant genebank concepts. 1999.

21. Review of how our collaborative effort has provided answers to some important questions on the genetics and physiology of cold tolerance in potato. 1998. Palta, J.P., J.B. Bamberg, Y.K. Chen, L.S. Weiss, and B.H. Karlsson. Understanding genetic control of freezing stress resistance using potato species as a model system. In: Plant cold hardiness: Molecular biology, biochemistry and physiology. P. Li and T.H.H. Chen, Eds. New York, Plenum Press, p.67-75, 40 refs.

22. Announcement of collecting progress in the USA. 1997. Bamberg, J.B., A.H. del Rio, and M.W. Martin. Expanding the geographical representation of ex situ germplasm samples of wild *Solanum jamesii* and *S. fendleri* from the USA. Am. Potato J. 74(6):416-417. [Abstr].

23. Tours of the NRSP-6 facilities. 1997-2004. Many professional and non-professional USA visitors and 22 scientists from 14 foreign countries (see Appendix 6 for details).

APPENDIX 2. Enabling technologies and information we have generated that helps us and others more efficiently use (collect, preserve and document) the germplasm in the NRSP-6 genebank. The gist of each accomplishment 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 44:1170-1177.

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 3. Preliminary evaluation that facilitates further research and breeding with NRSP-6 germplasm. The gist of each accomplishment 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.

APPENDIX 4. Sharing facilities, expertise, and providing special services and technology.

4A. Bamberg and associates

1. Bamberg guided other professionals on targeted collection trip to Arizona. ARS enhancement geneticist C. Brown and breeder J. Pavek for recollection of *S. fendleri* in Huachuca and Chiricahua mountains in search of new sources of chitwoodi nematode resistance. 2002. Sept 20-27. Materials now the subject of a research paper submitted to Am J. Potato Res.

2. del Rio invited to teach 2-credit Short Course "Use of molecular markers in the genetic analysis" in Peru. Faculty of Biological Sciences, Ricardo Palma University, Lima, Peru. 1997, 2002, 2003, 2004 (scheduled).

3. del Rio gave training to people who worked in our lab. 1997-2004. Private industry (2), Foreign (4), University (5).

4. Bamberg participated in graduate and undergraduate student training: <u>Del Rio, Alfonso</u>, MS and PhD (UW), June 1999, <u>Vega, Sandra</u>. MS and PhD (UW), Dec 1999. Hale, Anna Louise. Screening potato genotypes for antioxidant activity, identification of the responsible compounds, and differentiating Russet Norkotah strains using AFLP and microsatellite marker analysis. PhD. Texas A&M. Univ. (2003). <u>Moreyra-Pizzaro</u>, Rocio. Feb, 2003. Genetic consequences of clonal versus seed sampling in two wild potato species indigenous to the USA. MS (UW). <u>Undergrad mentored research</u>: Two Wisconsin undergrads in 2001: 1) Testing GA dwarf mutant as bioassay, 2) Testing phenol seed coat darkening as a germplasm descriptor. <u>Chen</u>, Yu-Kuang. Ph. D. (UW). Expression of freezing tolerance in interspecific F1 and somatic hybrids of potatoes.

Provided RAPD analysis of regional Ram's Horn orchid populations for The Nature Conservancy. 2002-2003. Opened doors for collecting *S. jamesii* on TNC land in Ramsay Canyon (AZ).

Made and donated herbarium specimens for other locations. Two sheets for each species in our collection to the National Arboretum (NA) herbarium. One sheet of each of 153 Bamberg et al. collections from the southwest USA to local herbaria (ARIZ, COLO, ASC, SRSC, UNM, BRY).

Made special-order tubers families and hybrids (not within the normal scope of our service). 1997-2004. Many cases in which we did this to facilitate evaluation both when we were, and were not direct collaborators in the project.

Developed and published optimum germplasm propagation and use protocols: 2002-2003 examples: Investigation of low germ seedlots, heat treatment of seeds, longer GA presoak, tetrazolium stain efficacy, optimum potting medium, crossing techniques, weed management, tuberization induction and tuber dormancy release.

4B. Spooner and associates

Invited lectures

a. One potato, two potato: how many species are there of wild potatoes? Wageningen Agricultural University, Wageningen, The Netherlands, February, 1998.

b. Collecting wild potatoes and taxonomy research in Latin America. University of Wisconsin-Whitewater, September, 1998.

c. Molecular taxonomy of wild tomatoes. University of California-Davis, November, 1998.

d. Evolving taxonomy of wild potatoes: Potato Association of America Annual Meeting, Fargo, North Dakota, 1998.

e. Current data on the systematics of the Solanaceae, with a focus on potatoes and tomatoes. Plant and Animal Genome VII Conference, San Diego, California, January, 1999.

f. Taxonomic distribution of disease resistance in wild potatoes. Department of Plant Pathology, University of Wisconsin-Madison, March, 1999.

g. Biosystematics of cultivated plants and their wild relatives in support of studies on the domestication of plants and the conservation of germplasm. Institute of Biology, National Autonomous University of Mexico (UNAM), Mexico City, May, 1999.

h. Collecting wild potatoes in Latin America: Rotary Club, Madison, Wisconsin, March, 2000.

i. Systematic studies in potatoes and tomatoes. University of Wisconsin-Whitewater, April, 2001.

j. Collecting wild potatoes in Latin America. Lion’s Club, Madison, Wisconsin, April, 2001.

k. Molecular systematics of potatoes and tomatoes. Jodrell Laboratories, Royal Botanic Gardens, Kew, January, 2001.

l. Molecular systematics of potatoes and tomatoes. Max-Plank Research Institute, Cologne, Germany, February, 2001.

m. Molecular systematics of potatoes and tomatoes. University of Copenhagen, Denmark, February, 2001.

n. What is the predictive value of taxonomies? Gatersleben Genebank, Germany, February, 2001.

o. Molecular systematics of potatoes and tomatoes. University of Vienna, Austria, February, 2001.

p. Molecular systematics of potatoes and tomatoes. Commonwealth Potato Collection, Dundee, Scotland, March, 2001.

q. One-day short course presented: Numerical methods for analysis of diversity and systematic data, Scientific Staff of the International Potato Center, Lima, Peru, April, 2001.

r. Collecting priorities for wild potatoes. Calvin C. Sperling Memorial Lectureship Series, Crop Science Society of America, Charlotte, North Carolina, June, 2001.

s. Adventures of a wild potato collector: Texas A&M University, January, 2002.

t. Research tools appropriate for the study of closely related accessions of crops and their wild relatives. New York Botanical Garden, February, 2002.

u. Methods to infer phylogenetic trees from molecular data. University of Wisconsin-Stevens Point, April, 2002.

v. Reduction of species in the wild potato *Solanum* section *Petota* series *Longipedicellata*: AFLP, RAPD and chloroplast SSR data. International Society for Horticultural Science, Toronto, Canada, August, 2002.

w. On overview of 15 years of potato collecting and taxonomy research. Department of Horticulture, University of Wisconsin-Madison Departmental Retreat, September 5, 2002.

x. Molecular methods for taxonomic work. Workshop in “Applications of Molecular Markers to the Conservation and Management of Agricultural Biodiversity (presented in Spanish), sponsored by the Technical Cooperation Program of Belgium, at the International Potato Center, Lima, Peru, September 27-Oct 2, 2002.

y. Crop evolution and domestication. Teach a 30-hour short course to plant breeding and plant genetics students, National University of Cuyo, Mendoza, Argentina, October 3-10, 2002 (12 students, presented in Spanish).

z. Domestication of the potato. Miami University (Ohio), October 25, 2002.

aa. Molecular markers and their use in taxonomy. Teach a 16-hour short course to Peruvian biologists, Universidad Mayor de San Marcos, Lima, Peru, April 8-9, 2003 (62 attendees from throughout Peru, presented in Spanish).

bb. Molecular studies of wild potatoes. Universidad Ricardo Palma, Lima, Peru, April 10, 2003 (presented in Spanish).

cc. Are potato disease resistance data associated with taxonomy and biogeography? Department of Plant Pathology, University of Wisconsin-Madison, September 19, 2003.

dd. Cultivated plants of Mesoamerica. Horticulture 375 (Tropical Horticulture), University of Wisconsin-Madison, October 6, 2003.

ee. Testing the predictive power of taxonomy and biogeography: a case study in wild potatoes. Department of Plant Pathology, University of Minnesota, December 9, 2003.

ff. Taxonomy and biogeography of potato and tomato. Plenary Lecture, Fifth Peruvian Congress of Genetics, March 22, 2004, Universidad Federico Villarreal, Lima, Peru (presented in Spanish).

gg. Are trait data associated with taxonomy and biogeography? International Potato Center, March 23, 2004 Lima, Peru.

hh. Are neutral molecular marker data appropriate for constructing core collections of genebanks? Cornell University, Ithaca New York, April 16, 2004.

Membership in Professional Societies.

American Society of Plant Taxonomists
Botanical Society of America
Crop Science Society of America
Potato Association of America
Sigma Xi
Society for Economic Botany
Society for the Study of Evolution
International Association for Plant Taxonomy

Office and Committee Assignments Held in Professional and Honorary Societies

a. Member, Organizing Committee, V International Solanaceae Congress, 1998-1999.

b. Member, International Solanaceae Taxonomic Database Committee, 1998-1999.

c. Member, Potato Crop Germplasm Committee (CGC), 1995-present.

d. Chair, International Organizing Committee and Local Arrangements Committee, VI International Solanaceae Congress. Spooner developed website for this conference at: http://www.hort.wisc.edu/PAA-Solanaceae/). To be held in Madison, Wisconsin 2006).

e. Chair, Economic Botany Section, Botanical Society of America, 2002-present.

f. Vice-Chair, Secretary, Chair, NCR-84 Potato Genetics Technical Committee, 2004-2006.

g. Secretary, Botanical Society of America, 2003-2006.

h. Member, Editorial Board, *Genetic Resources and Crop Evolution*, 2001-present.

i. Member, Editorial Board, *Kurtziana* (botanical taxonomic journal in Argentina), 2000-present.

j. Member, Editorial Board, *American Journal of Botany*, 2003-2006

k. Member, Local Arrangements Committee, Potato Association of America, 2002-2006.

l. Symposium organizer, *Ethnobotany of the Solanaceae*, Botanical Society of America Meetings, Madison Wisconsin, 2002.

m. Symposium organizer, *Transgenic Crops: Science*, *Policy*, *Politics*, Botanical Society of America Meetings, Mobile, Alabama, 2003 (reported on in *Science News* 164 [15]: 232-233. 2003).

Professional Advisory and Consulting Activities

a. Spooner has served as a grant reviewer for USDA Competitive Research Grants (Genetic Mechanisms and Molecular Biology, Plant Genome, Risk Assessment), a grant reviewer for National Science Foundation Grants (Systematic Biology), and for the National Geographic Society. Spooner has reviewed papers for the USDA, ARS peer-review system and has reviewed papers for American Journal of Botany, American Potato Journal (later named American Journal of Potato Research), Economic Botany, HortScience, Genetic Resources and Crop Evolution, HortScience, Molecular Phylogenetics and Evolution, Molecular Systematics and Evolution, Monographs in Systematic Botany of the Missouri Botanical Garden, Proceedings of the U.S. National Academy of Sciences, Sida, and Wildflower Magazine.

b. Spooner has served on five USDA RPES (Research Position Evaluation System) Panels.

c. Organizing member, ad-hoc Committee of the Potato Association of America, Breeding and Genetics Section. Charge to draft potato variety descriptors for the Plant Variety Protection Office, needed to fulfill the requirements of the Plant Variety Protection Act, 1994-1995.

d. At the invitation of the CGIAR (Consultative Group on International Agricultural Research Centers), SGRP (System-wide Genetic Resources Program), Spooner participated in a three-day workshop on Genebanks and Comparative Genetics, The Hague, The Netherlands, August, 1999.

e. At the invitation of the Missouri Botanical Garden, Spooner served as part of a working group on a four-day workshop to draft research priorities for the National Science Foundation for a possible new granting initiative on Ethnobiology Research, May, 2002. Spooner contributed to a White Paper to the National Science Foundation that is being used to lobby for ethnobiology funds (*Ethnobiology Working group. 2003. Intellectual imperatives in ethnobiology. Missouri Botanical Garden, St. Louis, 10 pp.*).

f. At the Invitation of Dr. Stephen Tanksley (Cornell University) Spooner participated in a one-day international workshop (November 3, 2003, Dulles, Virginia; invited for taxonomic expertise on tomatoes) on planning the sequencing of the tomato genome.

g. Spooner was invited by the International Potato Center (CIP) to collaborate with their scientists to write grants and papers for two months each year in 2003 and 2004. CIP paid Spooner's expenses for 2004, and grant proposal (if successfully funded) would continue this arrangement.

h. Spooner is a member of the faculty in the Department of Horticulture, University of Wisconsin-Madison and is also a member of the Plant Breeding and Plant Genetics Program. He has served on the Department of Horticulture Library, Colloquium, Promotion and Screening, Social, Academic Staff, and Space Committees, serving as chair of the latter four. Spooner served on the Plant Breeding and Plant Genetics Colloquium Committee. He authored an article on potato research in the Horticulture Department for a nationally distributed 2003 Annual Report. Spooner has guided his biological laboratory technician in her duties as the University Safety Committee Representative, and has graduated three graduate students for M.S. degrees, four graduate student for Ph.D. Degrees, and has guided a post-doctoral researcher. He currently has five graduate students working for Ph.D. Degrees.

i. Spooner has provided one lecture on an annual basis (1988-2002) for the Department of Horticulture Techniques of Plant Breeding Course (Hort/Agron 502). He has co-advised graduate students on three quarter-long Plant Breeding and Plant Genetics Seminar Series (Hort/Agron 957). The last of these was in 1997, on a topic of Crop Evolution and Domestication. With Dr. James Coors (Agronomy), he developed and team-taught a graduate-level course entitled “Crop Evolution and Domestication”1999.

j. Over the last five years, Spooner has served on three graduate student certification committees and has served on five graduate student Ph.D. oral examination committees (in addition to those of his own students).

k. Spooner served on the University of Wisconsin Department of Botany Search Committee for the Robert Kowal Plant Systematics Replacement Position in 1999.

l. Spooner led an effort to successfully nominate Alberto Salas, a collaborator at the International Potato Center, for a lifetime membership Award for the Potato Association of America, 2001.

g. Spooner served on the USDA Vegetable Crops Research Safety Committee for three years (2002-2005), and served as meeting recorder. He also directed an effort to write the Madison Area occupant safety plan.

h. Spooner served on the USDA Search Committee for the Robert Hanneman Potato Breeding Replacement Position in 2003.

i. Spooner led an effort to successfully nominate Christiane Anderson, Editor-in-Chief, *Systematic Botany* Monographs, for a Botanical Society of America lifetime achievement award for 2005.

3. Special Assignments

a) At the invitation of the Ministero Affari Esteri, Instituto Agronomico per L'Oltremare, Florence, Italy, Spooner participated in an International Conference entitled "Plant Genetic Resources for Food and Agriculture *in situ* and *ex situ*: where are the genes of importance for food security likely to come from? Ministero Affari Esteri, Instituto Agronomico per L'Oltremare, Florence, Italy, October, 1998."

b) At the invitation of the National University of Mexico, Spooner participated in an International Conference on characterization of biodiversity, Mexico City, May, 1999.

c) At the invitation of Peter Bretting, Spooner collaborated with Ann Marie Thro on a review of a report critiquing the introduction of transgenic plants into Austria. This resulted in a 72-page (single-page) report to Dr. Thro that she used as background material for her main report to the US Embassy in Austria.

Visitor's to Spooner's laboratory:

Visitor	Dates of visit to Spooner's laboratory	Organization	Research Interest/Accomplishments/Results
van den Berg (visiting scientist)	1999, 2001 (4-8 weeks/year)	Wageningen Agricultural University, The Netherlands	Potato taxonomy. 13 papers published (Taxon, Genet. Res. Crop. Evol., Pl. Syst. Evol., Euphytica, Syst. Bot., Amer. J. Bot.)

Rodríguez (visiting scientist)	2001 (one month each year)	Univ. Guadalajara, Mexico	Potato taxonomy. Later became Spooner's graduate student (1992-94). Four papers published (Potato Res., Syst. Bot., Acta Mex.), and Syst. Bot. Monogr. (tentatively accepted).
Castillo (visiting scientist)	2002 (one month, two weeks)	Plant Genet. Resources Program, Ecuador	Molecular systematics, later Spooner's graduate student (1992-1995). Four papers published (Euphytica, Syst. Bot., Amer. J. Bot.)
Huamán	1998, 2001 (two weeks/year)	International Potato Center, Lima, Peru	Write proposal to the USDA International Cooperation and Development. (Proposal funded, $27,900). Three papers published (Amer. J. Potato Res., Amer. J. Bot.)
Bonierbale	1998 (one week)	International Potato Center, Lima, Peru	Write research proposal to the USDA National Research Initiative (Proposal successfully funded, $220,000)
Hijmans	1999, 2000 (two weeks/year)	International Potato Center, Lima, Peru	Geographic Information Systems research. Four papers published (Amer. J. Potato Res, Amer. J. Bot., IPGRI Ecogeographical Stud. Crop Genepools, Euphytica)
Bryan	2001 (two weeks)	Scottish Crop Research Institute	Write a proposal for his institute that include funds for Spooner for visits to Scotland

			(successfully funded, visit planned for 2003). Systematics research (One paper published, Theor. Appl. Genet.)
Peralta	2002 (two weeks)	National University of Cuyo, Argentina	Write book chapter on tomato (in press)
Peralta	2003 (one month)	National University of Cuyo, Argentina	Write AFLP paper on tomato taxonomy (Taxon in press)

APPENDIX 5. Engagement and integration into the world of potato germplasm utilization in order to better understand, promote, and anticipate its needs. Note that all Regions are represented.

1. Bamberg's major participation in formal scientific meetings. Potato Association of America (1983-2003), NCR-84 Potato Genetics (1982-1998, 2000-2004), various others ad hoc.

2. Bamberg major administrative service.
--Steering Committee, Assn. of Potato Intergenebank Collaborators, APIC (1991-)
--Editor in Chief, Amer J. Potato Research (2003-)
--Chairman, Crop Germplasm Committee (1989-)
--National Rep for potato, Plant Germplasm Operations Comm. (1989-)

3. Bamberg collaboration for germplasm evaluation with other programs and visits to their 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 6. Acquisition, Preservation and Distribution Summary (1997-2003)

Acquisition

A total of 13 accessions were assigned PI numbers in 2003: two clones from Sweden, one from Poland, one from Mexico, five from the United Kingdom, and four populations from the SW United States.

A total of 73 seed accessions were assigned PI numbers in 2002: 16 from Russia, 27 from Poland, 11 from Bolivia, and 19 from the SW United States. Six clonal accessions were assigned PI numbers in 2002: 4 from Mexico, 1 from Poland, and 1 from Bolivia.

A total of 85 accessions were assigned PI numbers in 2001: 10 populations collected in the SW United States, 24 accessions from the spring quarantine increase (13 Russian breeding populations, 10 Peruvian collections, and 1 Mexican collection), and 51 clonal stocks (3 from Mexico, 1 from Bolivia, 18 from Peru, 9 from Poland, and 20 from Sweden).

A total of 24 accessions were assigned PI numbers in 2000: 24 in vitro clonal breeding stocks, 20 foreign varieties and 4 wild species populations.

A total of 145 accessions were assigned PI numbers in 1999: 80 in vitro clones, 58 quarantine clones, and seven populations from the southwest United States.

A total of 97 accessions were assigned PI's in 1998: 14 in vitro clones, 67 quarantine clones, and 16 populations from the southwest United States.

A total of 158 accessions were assigned PI's in 1997: 110 accessions as true seed and 48 as in vitro clones.

A total of 595 accessions were assigned PI's from 1997 – 2003 and are now maintained at the NRSP-6 US Potato Genebank.

Preservation

A total of 994 accessions were increased as botanical seed populations from 1997 to 2003. The entire clonal collection of about 900 in vitro items was propagated each year.

Distribution -- by receiving country

Country	Orders	UNITS
Argentina	2	38
Belarus	5	430
Belgium	1	2
Bolivia	4	1,665
Brazil	1	2
Canada	49	991
Chile	1	44
China	8	221
Colombia	5	60
Czech Republic	1	21
Denmark	1	2
Ethiopia	1	45
Finland	1	2
France	4	1,039
Germany	3	137
Hungary	5	163
Iceland	1	6
India	3	1,794
Indonesia	1	42
Italy	1	1
Japan	11	874
Korea, South	6	2,180
Kuwait	2	79
Mexico	8	1,258
Netherlands	9	184
Peru	12	2,529
Poland	5	83
Romania	2	3
Russian Federation	10	971
Scotland	1	1
Spain	4	69
Sweden	1	2
Switzerland	2	12
Turkey	2	16
United Kingdom	3	16
United States	696	40,408
Total	872	55,390

Distribution – by category (1997 – 2003)

	2003 Units[1]						
Category	S	TF	TS	IVS	HERB	TOTAL	PIs
Domestic	7,610	52	2,089	634	153	7,358	4,184
Foreign	1,090	11	32	309	0	1,442	1,151
NRSP-6[2]	2,833	0	0	0	0	6,013	1,510
Total	11,533	63	2,121	943	153	14,813	6,845

	2002 Units[1]						
Category	S	TF	TS	IVS	HERB	TOTAL	PIs
Domestic	3,165	613	186	583	215	4,762	4,074
Foreign	282	30	293	336	0	941	704
NRSP-6[2]	6,367	0	1	3	0	6,371	2,384
Total	9,814	643	480	922	215	12,074	7,162

	2001 Units[1]					
Category	S	TF	IVS	FSG	TOTAL	PIs
Domestic	5,553	302	1142	472	7,469	5,994
Foreign	546	0	55	80	681	612
NRSP-6[2]	4,061	0	17	0	4,078	1,571
Total	10,160	302	1,214	552	12,228	8,177

	2000 Units[1]					
Category	S	TF	IVS	FSG	TOTAL	PIs
Domestic	4,184	51	838	180	5,253	4,114
Foreign	4,249	0	236	284	4,769	3,177
NRSP-6[2]	5,259	0	0	0	5,259	1,378
Total	13,692	51	1,074	464	15,281	8,669

	1999 Units[1]					
Category	S	TF	IVS	FSG	TOTAL	PIs
Domestic	3,689	18	563	51	4,321	2,616
Foreign	1,443	3	246	108	1,800	1,177
NRSP-6[2]	9,931	0	0	0	9,931	1,388
Total	15,063	21	809	159	16,052	5,181

	1998 Units[1]					
Category	S	TF	IVS	FSG	TOTAL	PIs
Domestic	4,082	33	2112	42	6,269	2,593
Foreign	1,378	13	243	248	1,882	1,360
NRSP-6[2]	9,741	0	0	0	9,741	1,263
Total	15,201	46	2,355	290	17,892	5,216

	1997 Units[1]					
Category	S	TF	IVS	FSG	TOTAL	PIs
Domestic	4,285	9	682	0	4,976	3,074
Foreign	2,919	31	464	53	3,467	1,298
NRSP-6[2]	6,883	0	0	0	6,883	1,134
Total	14,087	40	1,146	0	15,326	5,506

	1997 - 2003 Units[1]							
Category	SEED	TF	TS	IVS	FSG	HERB	Total	PIs
Domestic	32,568	1,078	2,275	6,554	745	368	40,408	26,649
Foreign	11,907	88	325	1,889	773	0	14,982	9,479
NRSP-6[2]	45,075	0	1	20	0	0	48,276	10,628
Total	89,550	1,166	2,601	8,463	1465	368	103,666	46,756

[1] Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit): SEED= true seeds/(50), TF= tuber families/(10), TS=tuber stocks/(3), IVS=in vitro stocks/(1), FSG= fine screening cuttings/(2), HERB= herbarium specs/(1).

[2] Includes chromosome counts, germination tests, ID and Taxonomic check plantings, in vitro maintenance, seed increases, PSTV tests, miscellaneous plantings, and NSSL seed backup.

DOMESTIC DISTRIBUTIONS BY UNITS (1997 - 2003)

STATE	SPSEED	TF	FSG	IV	HE	REGION	UNITS	ACCNs
Illinois	15	0	0	0	0	NC	15	14
Indiana	21	0	0	0	0	NC	21	21
Iowa	1200	0	5	45	0	NC	1250	32
Michigan	132	5	526	165	0	NC	828	317
Minnesota	1355	38	0	129	0	NC	1522	1052
Missouri	29	0	0	16	0	NC	45	35
Nebraska	4	0	0	18	0	NC	22	10
North Dakota	219	28	0	636	0	NC	883	459
Ohio	2	0	226	0	0	NC	228	228
South Dakota	23	0	0	65	0	NC	88	45
Wisconsin	23101	155	1567	2618	0	NC	27441	19458
NC TOTALS	**26101**	**226**	**2324**	**3692**	**0**		**32343**	**21671**
Connecticut	0	0	0	3	0	NE	3	1
Deleware	5	0	0	3	0	NE	8	6
District of Colombia	399	5	0	0	215	NE	619	455
Maine	10	0	136	165	0	NE	311	200
Maryland	221	16	0	317	0	NE	554	313
Massachusetts	64	0	12	60	0	NE	136	58
New York	506	1	62	68	0	NE	637	186
Pennsylvania	22	0	4	83	0	NE	109	64
NE TOTALS	**1227**	**22**	**214**	**699**	**215**		**2377**	**1283**
Florida	3	12	0	93	0	S	108	39
Kentucky	28	0	0	3	0	S	31	10
North Carolina	171	12	2	3	0	S	188	187
Oklahoma	5	0	0	6	0	S	11	7
Tennessee	13	0	0	0	0	S	13	13
Texas	135	509	30	9	6	S	689	598
Virginia	22	4	0	41	0	S	67	39
S TOTALS	**377**	**537**	**32**	**155**	**6**		**1107**	**893**
Alaska	15	30	39	24	0	W	108	92
Arizona	0	0	0	0	68	W	68	68
California	678	159	227	1125	0	W	2189	1286
Colorado	189	10	0	155	6	W	360	268
Hawaii	75	0	0	0	0	W	75	75
Idaho	116	60	80	546	0	W	802	418
Montana	32	15	0	0	0	W	47	47
New Mexico	0	0	10	0	69	W	79	70
Oregon	65	16	80	20	0	W	181	122
Utah	4	2	3	0	4	W	13	13
Washington	509	1	11	138	0	W	659	396
W TOTALS	**1683**	**293**	**450**	**2008**	**147**		**4581**	**2855**
DOMESTIC UNITS	**29388**	**1078**	**3020**	**6554**	**368**		**40408**	**26702**

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