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IMPROVED BREEDING AND VARIETY EVALUATION METHODS TO REDUCE ACRYLAMIDE CONTENT AND INCREASE QUALITY IN PROCESSED POTATO PRODUCTS

NON-TECHNICAL SUMMARY: In 2002, acrylamide was discovered in carbohydrate rich foods processed at high temperatures. These include potato chips, French fries and other processed products that together account for over half of US potato consumption. The highest priority of the US potato industry is the need to introduce new varieties that reduce the acrylamide content of processed products and minimize health concerns related to acrylamide consumption. A partnership has developed among experts from industry, government and academia that focuses their collective effort on addressing this single need. The transdisciplinary approach described in this proposal builds on and extends industry-funded variety evaluation initiatives and the USDA AFRI SolCAP project that is developing molecular breeding tools for potato. Objectives are structured so that research and extension specialists across the US work with commercial potato growers, processing companies and end-users to address system-wide challenges related to new variety development and adoption. Areas of emphasis include research in potato breeding and genetics to improve potato quality, appearance, texture and taste to processor and end user specifications; identifying potato varieties that will reduce health concerns related to acrylamide in the production and processing of potatoes; and economic analysis focused on improving production efficiency, and profitability for growers and processors over the long term. The unprecedented level of participation across regions, disciplines and businesses that occurred as this proposal was developed highlights the commitment of the entire potato industry to this project. This work will accelerate the adoption of improved potato varieties by the commercial sector and achieve the goals of reducing the acrylamide content of processed potato products in the near term and decreasing acrylamide content to as low as reasonably achievable in the future.

OBJECTIVES: Potato is the most consumed vegetable in the US, with production valued at $3.5 billion. The long-term goal of this project is to facilitate the rapid, efficient development and adoption of new potato varieties that have exceptional agronomic, processing and consumer acceptance traits. An immediate critical need is to proactively reduce the acrylamide content of processed potato products in order to mitigate health concerns that have arisen with regard to acrylamide in food, and to remove the economic uncertainty associated with potential regulatory actions focused on acrylamide. Other critical

needs addressed are those for rapid incorporation of desirable traits into potato breeding clones and for rapid industry response to emerging challenges and changing consumer preferences. Specific outreach and research objectives include (1) expanding variety evaluation efforts with a focus on acrylamide reduction and new variety adoption; (2) defining criteria for tuber composition that will allow industry to reduce acrylamide to as low as reasonably achievable (ALARA) levels; (3) identifying single nucleotide polymorphism (SNP) markers linked to high value traits to more efficiently develop improved varieties in the long-term, (4) evaluating the costs, benefits, and risks of introducing new varieties, and quantifying consumer preferences and relative valuations of new varieties with novel attributes including low acrylamide; and (5) evaluating the best new varieties at multiple locations at a scale that allows for robust, system-wide assessment and creation of guidelines for best management practices.

APPROACH: Acrylamide in processed potato products is the highest priority concern of the US potato industry. The activities proposed here address this concern using a system-wide approach that employs research, extension and outreach activities to deal with critical needs related to the production, processing and consumer acceptance of potatoes. This research leverages and augments industry- and government-funded initiatives to achieve quantifiable results in the near term and lay the foundation for greater improvements over the long term. The research and extension activities proposed provide critical support to the potato industry in the areas of potato breeding and variety evaluation. A systematic evaluation of advanced breeding lines and recent cultivars that builds on industry-funded efforts will identify lines with high potential for reducing acrylamide in the near term. Consumer attribute testing will be used to determine the potential of new lines for commercialization. Genotypes that meet agronomic and consumer attribute criteria will be promoted for multiplication of seed tubers. Within the first 12 months, 2 processing and 2 chip lines will be identified for commercial evaluation and submitted for production of certified seed and another 4 lines identified within 24 months. These lines will be evaluated in large-scale pre-commercial trials in cooperation with growers, processing and chipping plants. Storage management recommendations will be developed for new varieties to improve the potential for commercial success. Achieving the longer-term goal of reducing acrylamide to as low as reasonably achievable levels will require directed breeding and selection. Developing molecular markers linked to high value traits in tetraploid potato is one way to increase the velocity of potato breeding programs. This research will define quantitative plant breeding targets for lines with low acrylamide forming potential using lines modified with molecular tools to produce a wide range of acrylamide precursors in tubers. The heritability of asparagine in potato will be determined using mapping populations and the range of asparagine in existing breeding clones will be quantified. A set of SNP markers linked to high-value traits for use with elite potato germplasm will be developed by leveraging the research ongoing in the SolCAP project. Research is also proposed to develop a more efficient, cost effective method to quantify reducing sugars, asparagine and acrylamide in potato samples using near-infrared spectroscopy. This would enable the evaluation of a wider range of breeding materials, facilitating potato breeding efforts. New varieties with improved quality and low acrylamide forming potential will benefit the potato industry by reducing food safety concerns and minimizing waste caused by inconsistent raw product quality. Adopting new varieties requires investment and entails risk. The economic value and risk of new varieties to growers and processors will be assessed through research in these areas. The value of new varieties to consumers will be quantified through research using consumer auction methods.

PROGRESS: 2011/09 TO 2016/08
Target Audience:The ultimate goal of this project is to develop and select potato cultivars that can be processed to potato chips and French fries with reduced amount of acrylamide.

Thus, consumers, potato growers, the potato processing industry and geneticists working with potato will benefit from this research project. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?Thirty-five undergraduate students, 22 graduate students and 9 post-doctorate fellows were supported by this grant. This project provides an excellent environment for training in comprehensive, cross-disciplinary research and extension activities. Students and post-doctorate fellows have received training in such diverse areas as traditional and molecular plant breeding, crop nutrient management, crop modeling, food science, molecular biology, and statistical analysis. Trainees have benefited from interactions with industry partners including commercial growers, field agronomists and raw product managers, food scientists and representatives of finished product customers. How have the results been disseminated to communities of interest?Results have been disseminated through regular meetings, calls and emails with leadership of the U. S. potato industry, and through presentations to and discussions with the larger community of stakeholders locally and nationally. Annual updates were provided to the project Advisory Committee and interested parties at the National Potato Council's Potato Expo. Three presentations in plenary sessions were made at the Potato Expo over the course of the project. A symposium on acrylamide reduction was presented at the Potato Association of America annual meeting in 2015. Additional presentations were made at Potato Expo, the National Potato Council summer meeting, multiple grower education conferences, the Potato Association of America annual meeting, regional field days, the National Fry Processing Trial Field Day, the combined NCCC215 plant breeding and Potatoes USA Chip Committee meeting and multiple national and international scientific meetings. Information was also disseminated though the project website and posting results from the National Chip Processing Trial and National Fry Processing Trial to online databases. Articles highlighting ongoing activities were published in peer-reviewed journals and in trade journals. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

IMPACT: 2011/09 TO 2016/08
What was accomplished under these goals? Objective 1. Impact. Fry processing clones with potential for making high quality, low-acrylamide products were identified. Chip processing lines that maintained low acrylamide precursors through long-term storage were identified and are being adopted by industry. This SCRI project is integrated with the industry-driven National Fry Processor Trial (NFPT), National Chip Processor Trial (NCPT) and Potatoes USA-Snack Food Association (SFA) trial. Each year, approximately 60 NFPT entries were selected by project participants and evaluated for agronomic traits, sugar and asparagine (asn) content of tubers and acrylamide content in fries. Tubers from all sites were inspected at the annual NFPT Field Day. JR Simplot and McCain Foods evaluated consumer attributes of select clones. An online NFPT database was created to facilitate assessment of individual lines. Many NFPT clones produced fries with lower acrylamide contents than standard varieties and these data were published in Crop Science. Low acrylamide clones Payette Russet, Dakota Russet and Easton were released as varieties. POR06V12-3 and AO96141-3 will soon be released as Castle Russet and Echo Russet. The NCPT evaluated approximately 200 early generation clones at 11 locations in each year of the program. Fifteen clones advanced to the SFA trial at 11 locations. Clones with greatest potential for meeting industry needs were processed into chips at commercial plants and evaluated for taste and acrylamide content. Few differences in taste were observed between established varieties and new clones. Chipping varieties Lamoka, Waneta, and Pinnacle were evaluated in bulk-storage bins and maintained outstanding chip quality through long-term storage. Objective 2. Impact. Fry and chip processing lines genetically modified to have low acrylamide precursors were used to demonstrate dramatic reductions in acrylamide content of fried products and opportunities for improved tuber quality. New phenotyping methods for tuber solids and sugar content as well as acrylamide content in finished products were developed.

Potato families from the intercrossing of lower acrylamide parents were generated and are being evaluated as early selections in the field. Russet Burbank and Ranger Russet lines in which the invertase gene was silenced had fewer sugar end defects and made lower acrylamide products than control lines. These data were published in PLoS ONE. Russet Burbank lines in which the invertase gene and asn synthetase genes were silenced had decreased tuber reducing sugars, asn content and acrylamide-forming potential. Findings were published in Plant Biotechnology Journal. The stability and heritability of invertase silencing using RNA interference was evaluated by crossing low-invertase RNA-interference lines with non-GM lines. Time and temperature-dependent changes in gene expression and tuber carbohydrates were quantified and used to create a model for how storage environment and duration influence chip quality. Findings were published in BMC Research Notes and Postharvest Biology and Technology. Detrimental effects of elevated soil temperature on post-harvest sugars and fry quality were quantified and results were published in Planta. A method for using near-infrared spectroscopy to rapidly predict acrylamide content was developed and published in Journal of Agricultural and Food Chemistry. This research was extended to fried sweet potato. A method for quantifying specific gravity and sucrose in raw tubers using reflectance spectroscopy was developed. This method could facilitate phenotyping potatoes for variation in solids content and tuber maturity. Objective 3. Impact. Chipping potatoes were bred for low amounts of the acrylamide precursor asparagine. Multiple QTL for fry and chip processing quality and acrylamide precursors were identified and these can be used to make future potato breeding efforts more efficient. Progeny of a cross between two low-asparagine clones were evaluated for asparagine and chip processing traits. Further analysis will determine if low tuber asparagine content reduced chip acrylamide content. Quantitative trait loci (QTL) analysis is continuing. Linkage maps for parents of 43 russet clones were constructed and QTL for reducing sugars, specific gravity and other traits were detected. Similar QTL analyses are underway for chipping potato populations. Computational methods for identifying marker-trait associations in potato breeding populations were developed and published in Plant Genome. The software was posted online and is being used by other research groups. Objective 4. Impact. Willingness to pay for low acrylamide products was found to depend strongly on the information consumers have about acrylamide and acrylamide reduction through biotechnology. New varieties may decrease return to growers if demand is static. Experiments were conducted to determine consumer's willingness to pay for low acrylamide potato products achieved using biotechnology. Information statements relevant to acrylamide were provided to participants. Consumer's willingness to pay depended strongly on the information provided to them. A manuscript describing aspects of this work was published in Journal of Agriculture and Resource Economics. Consumer perception of French fries prepared from standard varieties or conventionally-bred, low-acrylamide varieties is being assessed using taste tests, questionnaires and information statements. Modest reductions in farm income may occur if improved, low-acrylamide fry processing varieties are adopted widely, but likely impact depends strongly on demand. Objective 5. Impact. Over 8 tons of potato seed tubers were generated and distributed to cooperating fry processors for use in commercial trials. Agronomic and storage trials provided guidance to industry on characteristics of new varieties with low acrylamide-forming. Virus-free plantlets, mini tubers and seed tubers of Dakota Russet, Payette Russet, AF4296-3, and AC96052-1RU were produced. Seeds were used by industry for agronomic trials in WA, ID, WI, ND, ME and NB. Mini tubers of AF4296-3 were increased by a cooperator and 4.5 ha of resulting seeds were planted in 2016 to support commercial processing evaluations. A total of 4,500 kg of Dakota Russet seeds were provided to a fry processor in 2015 and 3 cooperating fry processors each received 3,900 kg of Payette Russet seed in 2016 to support commercial evaluations. SCRI agronomic trials in WA, OR, ID, MN, WI and ME quantified tuber yield, size profile, specific gravity, and defects in 7-10 clones. Fries from trial lines were used for processing quality, acrylamide and consumer

attribute testing and storage evaluations. Data were shared with industry. In WA, Clearwater Russet, Dakota Russet, and 3 other clones were evaluated for yield response and effects on physiological maturity to 4 levels of nitrogen (N). Entries in regional trials were screened for tuber asparagine. In MN, responses of Easton and Dakota Russet to N-rate relative to Russet Burbank were examined. Results from the first two years of this trial were provided to growers. In ME, N-rate responses of Easton, Caribou Russet, and AF4296-3 were compared to Russet Burbank. Acrylamide in fries from Russet Burbank, Easton and AF4296-3 increased as N-rate increased, but levels in Easton and AF4296-3 were far below those of Russet Burbank. In ID, Russet Burbank, Clearwater Russet, AF4296-3 and Dakota Russet were evaluated at 4 N-rates. The lower N treatment produced tubers with higher glucose levels. Acrylamide in fries after 4 months in storage ranged from 95 to 398 ppb and the highest levels were observed in Russet Burbank. Project researchers and McCain Foods conducted a semi-commercial storage bin study of Easton, which stored until April with better fry color and uniformity than Russet Burbank.

PUBLICATIONS (not previously reported): 2011/09 TO 2016/08

1. Type: Journal Articles Status: Published Year Published: 2013 Citation: Bethke, P.C. (2013). Reducing the acrylamide content of processed potato products through germplasm improvement: Opportunities, challenges and progress. Aspects of Applied Biology 116: 79-87.
2. Type: Journal Articles Status: Published Year Published: 2016 Citation: Adedipe, O.E., S.D. Johanningsmeier, V.D. Truong, and G.C. Yencho. (2016). Development and validation of a near-infrared spectroscopy method for the prediction of acrylamide content in French-fried potato. Journal of Agricultural and Food Chemistry 64:1850-1860.
3. Type: Journal Articles Status: Published Year Published: 2016 Citation: Jansky, S.H., A.O. Charkowski, D.S. Douches, G. Gusmini, C. Richael, P.C. Bethke et al. (2016). Reinventing potato as a diploid inbred line-based crop. Crop Science 56: 1412-1422.
4. Type: Journal Articles Status: Published Year Published: 2016 Citation: Lacy, K. and W.E. Huffman. (2016). Consumer demand for potato products and willingness-to-pay for low-acrylamide, sulfite-free fresh potatoes and dices: evidence from lab auctions. Journal of Agricultural and Resource Economics. 41: 116-137.
5. Type: Journal Articles Status: Submitted Year Published: 2016 Citation: Novy, R.G., J.L. Whitworth, J.C. Stark, B.L. Schneider, N.R. Knowles, M.J. Pavek, L.O. Knowles, B.A. Charlton, V. Sathuvalli, S. Yilma, C.R. Brown, M. Thornton, T.L. Brandt, and N. Olsen. (2016). Payette Russet: A dual-purpose potato cultivar with cold-sweetening resistance, low acrylamide formation, and resistance to late blight and potato virus Y. American Journal of Potato Research
6. Type: Journal Articles Status: Published Year Published: 2016 Citation: Rosyara, U.R., W.S. De Jong, D.S. Douches, and J.B. Endelman. (2016). Software for genome-wide association studies in autopolyploids and its application to potato. Plant Genome 9: doi:10.3835/plantgenome2015.08.0073.
7. Type: Journal Articles Status: Published Year Published: 2016 Citation: Stark, J.C., R.G. Novy, J.L. Whitworth, N.R. Knowles, M.J. Pavek, M. Thornton, R. Spear, C.R. Brown, B.A. Charlton, V. Sathuvalli, S. Yilma, N. Olsen, and T.L. Brandt. (2016). Mountain Gem Russet: a Potato variety with high early and full season yield potential and excellent fresh market and early processing characteristics. American Journal of Potato Research 93: 158-171.
8. Type: Journal Articles Status: Published Year Published: 2016 Citation: Wang, Y., P.C. Bethke, A.J. Bussan, M.T. Glynn, D.G. Holm, F.M. Navarro, R.G. Novy, J.P. Palta, M.J. Pavek, G.A. Porter, V.R. Sathuvalli, A.L. Thompson, P.J. Voglewede, J.L. Whitworth, D.I. Parish, and J.B. Endelman. (2016). Acrylamide-forming potential and agronomic properties of elite U.S. potato germplasm from the National Fry Processing Trial. Crop Science 56: 30-39.
9. Type: Journal Articles Status: Published Year Published: 2016 Citation: Wiberley-

Bradford, A.E., J.S. Busse, and P.C. Bethke. (2016). Temperature-dependent regulation of sugar metabolism in wild-type and low-invertase transgenic chipping potatoes during and after cooling for low-temperature storage. Postharvest Biology and Technology 115: 60-71.
10. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Bethke, P.C. (2016). Progress and success of the SCRI Acrylamide project. Proceedings of the 99th Annual Meeting of the Potato Association of America. 93: 122.
11. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Brandt, T., N. Olsen and M. Thornton. (2016). Effects of nitrogen fertilizer managament on post-harvest performance of Russet Burbank and three low acrylamide potato clones. American Journal of Potato Research 93: 123-124.
12. Type: Journal Articles Status: Published Year Published: 2016 Citation: Zhu, X., H.L. Gong, Q.Y. He, Z.X. Zeng, J.S. Busse, W.W. Jin, P.C. Bethke, and J.M. Jiang. (2016). Silencing of vacuolar invertase and asparagine synthetase genes and its impact on acrylamide formation of fried potato products. Plant Biotech. J. 14: 709-718.
13. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Gause, K., G.A. Porter, L.B. Perkins, and M.E. Camire. (2014). Nitrogen and potassium effects on potato yield, quality, and acrylamide-forming potential. American Journal of Potato Research 91: 48.
14. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Knowles, N.R., M.J. Pavek, N. Fuller, and L.O. Knowles. (2014). Post harvest quality of new clones and cultivars. In Washington State Potato Commission Progress Reports for the year 2013, 22 pp.
15. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Pavek, M.J. and N.R. Knowles. (2014). WSU potato cultivar yield and postharvest quality evaluations for 2013. Washington State University Special Report. 110 pp.
16. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Knowles, N.R., M.J. Pavek, and L.O. Knowles. (2015). Developmental profiles, nitrogen use and postharvest quality of Alpine & Sage Russet Potatoes in the Columbia Basin. Annual Washington and Oregon Potato Conference, Jan. 27-30, Kennewick, WA.
17. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Novy, R., J. Whitworth, J. Stark, B. Charlton, S. Yilma, V. Sathuvalli, N.R. Knowles, M. Pavek, R. Spear, T. Brandt, N. Olsen, M. Thornton, C. Brown, and J. Debons. (2015). A02507-2LB and A03158-2TE: Promising breeding clones from the Northwest (Tri-State) Potato Variety Development Program. American Journal of Potato Research 92: 202.
18. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Sun, N., C. Rosen, J. Crants, M. McNearney and M. Glynn. (2015). Response of new potato cultivars developed for low tuber reducing sugars to nitrogen management. ASA/CSSA/SSSA annual meeting. Minneapolis, MN.
19. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Woodell, L. and N. Olsen. (2015). Clearwater Russet, Fusarium dry rot and Stadium. Idaho Association of Plant Protection. Jerome, ID.
20. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Herman, D.J., L.O. Knowles, and N.R. Knowles. (2016). Screening sweetening-resistant clones for tolerance to heat stress. Proceedings of the 99th Annual Meeting of the Potato Association of America 93: 132-133.
21. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Knowles, N.R., L.O. Knowles, G.N.M. Kumar, M.J. Pavek, and N. Olsen. (2016). Effects of in-season management and stress on retention of postharvest quality. Northwest Potato Research Consortium Progress Reports for the year 2015, 20 pp.
22. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Ocaya, P., K. Gause, and G.A. Porter. (2016). Nitrogen rate response of Russet Burbank and four new fry processing varieties. American Journal of Potato Research. 93: 138.

23. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Pavek, M.J. and N.R. Knowles. (2016). WSU potato cultivar yield and postharvest quality evaluations for 2015. Washington State University Special Report, 114 pp.
24. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Porter, G.A., P. Ocaya, and T. Mills. (2016). Easton: A new potato variety for fry processing that has excellent fried-product color and resistance to hollow heart and Verticillium wilt. American Journal of Potato Research 93: 139-140.
25. Type: Conference Papers and Presentations Status: Awaiting Publication Year Published: 2016 Citation: Porter, G.A. and P. Ocaya. (2016). Processing quality of advanced fry processing varieties versus Russet Burbank in SCRI Agronomic Trials, Maine 2013-2015. American Journal of Potato Research.
26. Type: Conference Papers and Presentations Status: Awaiting Publication Year Published: 2016 Citation: Porter, G.A., P. Ocaya, L.B. Perkins, and M.E. Camire. (2016). Nitrogen effects on fry processing quality of Russet Burbank, Easton, and AF4296-3 potato varieties. American Journal of Potato Research.
27. Type: Conference Papers and Presentations Status: Awaiting Publication Year Published: 2016 Citation: Porter, G.A., P. Ocaya, and T. Mills. (2016). Caribou Russet: A new russet potato variety for fresh market and fry processing. American Journal of Potato Research.
28. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Rosen, C.J., N. Sun, N. Olsen, M. K. Thornton, N. R. Knowles, L. O. Knowles, and M. J. Pavek. (2016). Impact of agronomic and storage practices on acrylamide. American Journal of Potato Research 93: 141.
29. Type: Conference Papers and Presentations Status: Awaiting Publication Year Published: 2016 Citation: Wang, Y., Endelman, J., and Bethke, P.C. (2016). A national effort to identify fry processing clones with low acrylamide-forming potential. Proceedings of the 99th Annual Meeting of the Potato Association of America.
30. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Wiberley-Bradford, A., J.S. Busse, and P.C. Bethke. (2016). Heat stress during development alters post-harvest sugar contents and chip processing quality of potato tubers. Proceedings of the 99th Annual Meeting of the Potato Association of America 93: 148.
31. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Wiberley-Bradford, A., J.S. Busse, and P.C. Bethke. (2016). Regulation of sugar metabolism in wild-type and low-invertase transgenic chipping potatoes during and after cooling for low-temperature storage. Proceedings of the 99th Annual Meeting of the Potato Association of America 93: 148.
32. Type: Conference Papers and Presentations Status: Published Year Published: 2016 Citation: Woodell, N., C. Rosen, J. Crants, and M. McNearney. (2016). Nitrogen response of new potato varieties selected for low tuber reducing sugars. Proceedings from the Minnesota Area II Potato Research and Promotion Council and the Northern Plains Potato Growers Association Research Reports 98-105.
33. Type: Theses/Dissertations Status: Published Year Published: 2016 Citation: Dickman, L (2016) Stem end chipping defect incidence and severity in potatoes (Solanum tuberosum). M.S. Thesis, University of Wisconsin.
34. Type: Other Status: Published Year Published: 2015 Citation: Bethke, P.C., Y. Wang, J.B. Endelman. (2015). National variety trials identify clones with high potential for excellence. The Badger Common?Tater 67: 20-21.
35. Type: Other Status: Published Year Published: 2016 Citation: Mitchell, P.D., F. Dong, and P.C. Bethke. (2016). Can Innate potato impact market prices and farmer income? The Badger Common?Tater 68: 48-53.
36. Type: Other Status: Awaiting Publication Year Published: 2016 Citation: Bethke, P.C., and A.E. Wiberley-Bradford. (2016). New Insights into Cold-induced Sweetening. The BadgerCommon?Tater.

37. Type: Other Status: Published Year Published: 2012 Citation: Bussan, A.J. and P.C. Bethke. (2012). SCRI Advisory Committee meeting. National Potato Council Potato Expo, Orlando, PL. January 4, 2012.
38. Type: Other Status: Published Year Published: 2012 Citation: Bethke, P.C. (2012). Reducing the acrylamide content of processed potato products through germplasm improvement: opportunities, challenges and progress. Meeting on Acrylamide, furans and other food-borne contaminants, from plant science to food chemistry. Association of Applied Biologists, Freising, Germany, October 8-9, 2012.
39. Type: Other Status: Published Year Published: 2012 Citation: Halverson, G., P.C. Bethke, and A.J. Bussan. (2012). Acrylamide: Seeking an industry solution. Presented twice at National Potato Council Potato Expo, Orlando, FL. January 5, 2012.
40. Type: Other Status: Published Year Published: 2013 Citation: Adedipe, O. (2013). Quantification of acrylamide in raw and fried potatoes (Solanum tuberosum) using near infrared spectroscopy (NIRS). USDA-ARS Unit, Department of Food, and Bioprocessing & Nutrition Sciences, North Carolina State University, August 16, 2013.
41. Type: Other Status: Published Year Published: 2013 Citation: Bussan, A.J. and P.C. Bethke. (2013). NFPT and SCRI project update. NFPT Field Day, East Grand Forks, MN, October 8-9, 2013.
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43. Type: Other Status: Published Year Published: 2015 Citation: Bethke, P.C. (2015). Progress and success of the SCRI acrylamide project. Symposium presentation at Potato Association of America annual meeting, Portland, ME, July 19-23, 2015.
44. Type: Other Status: Published Year Published: 2015 Citation: Douches, D. (2015). Potato Breeding and Genetics Update. NCCC215 North Central Potato Breeding and Genetics meeting, Chicago, IL December 5, 2015.
45. Type: Other Status: Published Year Published: 2015 Citation: Novy, R. (2015). Current research and future insights in potato breeding and variety development. 50th Montana Seed Potato Seminar. Missoula, MT, November 5, 2015.
46. Type: Other Status: Published Year Published: 2015 Citation: Olsen, N., M.J. Frazier, L. Woodell, T. Brandt and Y. Wang. (2015). University of Idaho potato storage research and extension program. Kimberly Potato Storage Advisory Committee Meeting. Kimberly, ID. November 10, 2015.
47. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A. (2015). Potato breeding and variety development. Presentation to Vice President Ward?s Maine Legislative VIP Tour Group, University of Maine, January 14, 2015, Orono, ME.
48. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A. (2015). New potato varieties, upcoming releases and licensing opportunities. Presentation to the Maine Potato Board and University of Maine Potato Variety Release Advisory Committee, February 11, 2015, Presque Isle, ME.
49. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A. and P. Ocaya. (2015). Progress report on new potato variety challenge grant program and potato variety research - 2014 Growing Season. Presentation to the Maine Potato Board Research Subcommittee, February 11, 2015, Presque Isle, ME.
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2015, Presque Isle, ME.
52. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A., P. Ocaya, and T. Mills. (2015). Easton: A new potato variety for fry processing that has excellent fried-product color and resistance to hollow heart and Verticillium wilt. Presentation at the 99th Annual Meeting of the Potato Association of America, Portland, ME. July 22, 2015.
53. Type: Other Status: Published Year Published: 2015 Citation: Rosyara, U. and J.B. Endelman. (2015). Genome-wide association studies for autopolyploids - potato. Plant and Animal Genome XXIII. San Diego, CA January 10-14, 2015.
54. Type: Other Status: Published Year Published: 2015 Citation: Rosyara, U.R., W.S. DeJong, D.S. Douches, and J.B. Endelman. (2015). Software for genome-wide association studies in autopolyploids and its application to potato. Breeding Section Meeting of the European Association for Potato Research. Vico Equense, Italy, Nov 15?18, 2015.
55. Type: Other Status: Published Year Published: 2015 Citation: Thornton, M., N. Olsen, and R. Novy. (2015). Agronomic and storage characteristics of new low acrylamide lines. 47th Annual Idaho Potato Conference. Pocatello, ID, January 21, 2015.
56. Type: Other Status: Published Year Published: 2015 Citation: Wiberley-Bradford, A., J.S. Busse, and P.C. Bethke. (2015). Heat stress during development alters post-harvest sugar contents and chip processing quality of potato tubers. Potato Association of America annual meeting, Portland ME, July 19-23, 2015.
57. Type: Other Status: Published Year Published: 2015 Citation: Wiberley-Bradford, A., J.S. Busse, and P.C. Bethke. (2015). Regulation of sugar metabolism in wild-type and low-invertase transgenic chipping potatoes during and after cooling for low-temperature storage. Potato Association of America annual meeting, Portland ME, July 19-23, 2015.
58. Type: Other Status: Published Year Published: 2016 Citation: Bethke, P.C. (2016) Update on the national acrylamide project. WPVGA and UW Extension Grower Education Conference, Stevens Point, WI, February 2, 2016.
59. Type: Other Status: Published Year Published: 2016 Citation: Bethke, P.C. (2016) Update on chipping potato tuber storage quality research. Potatoes USA Chip Committee meeting, Park City UT, July 11, 2016.
60. Type: Other Status: Published Year Published: 2016 Citation: Bethke, P.C. (2016). SCRI Project Director workshop at American Society of Horticultural Sciences annual meeting. Atlanta, GA, August 10, 2016.
61. Type: Other Status: Published Year Published: 2016 Citation: Douches, D. (2016). Potato Breeding and Genetics Research Report. Michigan Potato Industry Commission Research Committee. January 21, 2016.
62. Type: Other Status: Published Year Published: 2016 Citation: Douches, D. (2016) Potato preeding and genetics 2015 update. Michigan Winter Potato Conference, February 11, 2016.
63. Type: Other Status: Published Year Published: 2016 Citation: Frederick, C., J. Couture, and P.C. Bethke. (2016). Evaluation of hyperspectral reflectance for estimating dry matter and sugar concentration in processing potatoes. Potato Association of America annual meeting, Grand Rapids, MI, July 31-August 3, 2016.
64. Type: Other Status: Published Year Published: 2016 Citation: Knowles, N.R., L.O. Knowles, G. Ellis, D. Herman, and M.J. Pavek. (2016). In-season stress and retention of postharvest quality. WSU Annual Potato Field Day, IAERC, Othello, WA, June 23 2016.
65. Type: Other Status: Published Year Published: 2016 Citation: Knowles, N.R., N. Fuller, and L.O. Knowles. (2016). Postharvest quality evaluations and related management work. Cultivar Performance Workshop, Annual Washington and Oregon Potato Conference, Kennewick, WA, Jan. 26-28, 2016.
66. Type: Other Status: Published Year Published: 2016 Citation: Knowles, N.R., M.J. Pavek, and L.O. Knowles. (2016). Nitrogen fertility and tuber physiological maturity affect acrylamide precursors and forming potential. Presentation given at Potato Expo, Las Vegas, NV, January 10, 2016.

67. Type: Other Status: Published Year Published: 2016 Citation: Bethke, P.C. (2016) Acrylamide in processed potato products. American Society of Horticultural Science annual meeting, Atlanta, GA, August 8-11, 2016.
68. Type: Other Status: Published Year Published: 2016 Citation: Bethke, P.C., N.R. Knowles, Y. Wang, N. Olsen, D. Parish, J. Endelman (2016). SCRI Acrylamide program update. SCRI Acrylamide Advisory Committee meeting at National Potato Council Potato Expo, Las Vegas, NV, January 12, 2016.
69. Type: Other Status: Published Year Published: 2016 Citation: Douches, D. (2016). Improving Economic Traits in Cultivated Potato. Plant and Animal Genome meeting, San Diego, CA, January 11, 2016.
70. Type: Other Status: Published Year Published: 2016 Citation: Massa, A., R. Novy, C. Yencho, and D. Douches. (2016). Linkage analysis and QTL mapping in a russet tetraploid mapping population. Potato Association of America 100th meeting. Grand Rapids, MI.
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74. Type: Other Status: Published Year Published: 2016 Citation: Olsen, N. (2016). Storage of Clearwater Russet and Dakota Russet. Simplot Food Group, Caldwell, ID, June 15, 2016.
75. Type: Other Status: Published Year Published: 2016 Citation: Olsen, N., R. Novy, J. Stark, and A. Waxman. (2016). New Variety Management. Idaho Potato Conference, Pocatello, ID. January 20, 2016.
76. Type: Other Status: Published Year Published: 2016 Citation: Porter, G.A. and P. Ocaya. (2016). Processing quality of advanced fry processing varieties versus Russet Burbank in SCRI Agronomic Trials, Maine 2013-2015. Presentation at the 100th Annual Meeting of the Potato Association of America, Grand Rapids, MI. July 31 to August 4, 2016.
77. Type: Other Status: Published Year Published: 2016 Citation: Porter, G.A., P. Ocaya, and T. Mills. (2016). Caribou Russet: A new russet potato variety for fresh market and fry processing. Presentation at the 100th Annual Meeting of the Potato Association of America, Grand Rapids, MI. July 31 to August 4, 2016.
78. Type: Other Status: Published Year Published: 2016 Citation: Porter, G.A., P. Ocaya, L.B. Perkins, and M.E. Camire. (2016). Nitrogen effects on fry processing quality of Russet Burbank, Easton, and AF4296-3 potato varieties. Presentation at the 100th Annual Meeting of the Potato Association of America, Grand Rapids, MI. July 31 to August 4, 2016.
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82. Type: Other Status: Published Year Published: 2016 Citation: Sun N., C. Rosen, J. Crants, and M. McNearney. (2016). Nitrogen and cultivar effects on tuber acrylamide precursors during the growing season and storage. Annual Potato Association of America meetings, Grand Rapids, MI, July 31-August 4, 2016.
83. Type: Other Status: Published Year Published: 2016 Citation: Xiao Q., R. Reynolds, V.D. Truong, S. Johanningsmeier, K. Pecota, and C. Yencho. (2016). Non-enzymatic browning and acrylamide formation in fried chips as affected by sweetpotato genotypes and curing process. Annual International Food Technology Meeting, Chicago, IL. July 16-19, 2016.

PROGRESS: 2014/09/01 TO 2015/08/31
Target Audience:The ultimate goal of this project is to develop and select potato cultivars that can be processed to potato chips and French fries with reduced amount of acrylamide. Thus, consumers, potato growers, the potato processing industry and geneticists working with potatoes will benefit from this research project. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?Twenty-six undergraduate students, 10 graduate students and 5 post-doctorate fellows were supported by this grant during the current reporting period. This project provides an excellent environment for training in comprehensive, cross-disciplinary research and extension activities. Students and post-doctorate fellows have received training in such diverse areas as traditional and molecular plant breeding, crop nutrient management, crop modeling, food science, molecular biology, and statistical analysis. Trainees have benefited from interactions with industry partners including commercial growers, field agronomists and raw product managers, food scientists and representatives of finished product customers. How have the results been disseminated to communities of interest?Results have been disseminated through regular meetings, calls and emails with leadership of the U. S. potato industry, and through presentations to and discussions with the larger community of stakeholders locally and nationally. Activities during this reporting period include providing a two-hour presentation to the project Advisory Committee and interested parties at the National Potato Council's Potato Expo. Additional presentations were made at the Potato Expo, multiple grower education conferences, the Potato Association of America annual meeting, several regional field days, the National Fry processing Trial field day, the NCCC215 plant breeding meeting and multiple national and international scientific meetings. Information was also disseminated though the project website and posting results from the National Chip Processing Trial and National Fry Processing Trial to online databases. Articles highlighting ongoing activities were published in trade journals. What do you plan to do during the next reporting period to accomplish the goals?During the next reporting period, we will continue to build on the success that we have had during the previous years. Continued dialog and engagement with industry will be a high priority. We believe that we are on track to accomplish the goals established for the project. As additional data are generated and evaluated by project participants and members of industry, we expect that there will be adjustment of activities to take full advantage of opportunities that arise, or to shift resources from areas where progress has been more rapid than expected. As an example, we have committed available resources to extend grant-funded activities in the National Fry Processor Trial. This trial was prioritized because fries contribute the largest percentage of acrylamide to the U.S. diet, and data gathered so far indicate that substantial acrylamide reductions in fries may be achievable by using newly developed clones. We are also focusing additional resources on computational tools for the analysis of genetic data, as a way of increasing our capacity to do molecular breeding in potato. This change in emphasis is strongly supported by the processing industry. We have also increased research on the relationship between tuber asparagine content in chipping potatoes and acrylamide content in chips. Improved tools for rapid phenotyping of high value potato traits are needed and we have initiated research in that area.

IMPACT: 2014/09/01 TO 2015/08/31
What was accomplished under these goals? Objective 1. This SCRI project is integrated with the industry-driven National Fry Processor Trial (NFPT), National Chip Processor Trial (NCPT) and US Potato Board (USPB)-Snack Food Association (SFA) trial. NFPT sites in WI and ME were funded by this SCRI project and industry funded sites in WA, ID and ND. Project researchers, potato breeders and industry selected trial entries, 68 in 2014 and 55 in 2015. Participants inspected tubers at the NFPT Field day. Tuber variation in specific gravity, sugar and asparagine (asn) content of tubers and acrylamide content in fries were quantified. Select clones were processed into fries and evaluated for consumer attributes by JR Simplot (WA, ID, and ND samples) and McCain Foods (WI and ME samples). The NFPT database was updated and expanded. Many NFPT clones produced fries with lower acrylamide contents than standard varieties. NFPT lines with potential for commercial success were entered into SCRI Agronomic trials. Low acrylamide clone A02507-2LB was released as Payette Russet. French fries made from Payette Russet average 75% less acrylamide than fries made from the potato variety Russet Burbank, the industry standard. The NCPT evaluated approximately 200 early generation clones at 11 locations in 2014 and 2015. Activities in OR were funded by this SCRI project. Clones with favorable attributes were advanced to the USPB SFA trial. That trial had 15 clones at 11 locations in 2014-2015. The OR site was funded by this project. Clones from the USPB SFA trial with greatest potential for meeting industry goals were processed into chips at commercial plants operated by project cooperators. Comparisons of potato chip taste were conducted using triangle tests. Few differences in taste were observed between established varieties and new clones. Objective 2. Potato families from the intercrossing of lower acrylamide parents were generated and transplanted for seedling tuber production and subsequent field selection. Clones selected in the field in 2014 were planted for evaluation and selection in the fall of 2015. Russet Burbank lines with a range of vacuolar invertase and asn synthetase gene expression as a result of silencing by RNA-interference were grown from seed tubers. Some lines exhibited chlorosis and poor growth while others had normal growth. Effects of invertase and/or asn synthetase silencing on yield, tuber reducing sugars and asn content, and acrylamide-forming potential were published in Plant Biotechnology Journal. Research on how slow cooling and storage temperature affect tuber metabolism and chip processing quality continued. Temperature-dependent changes in gene expression and tuber carbohydrates were quantified and used to create a model for how storage environment and duration influence chip quality. A manuscript describing this work was submitted. Progress was made on implementation of near-infrared spectroscopy (NIRS) as a method to rapidly predict acrylamide content in French fries and potato chips. Prediction errors for acrylamide were 50 µg/kg in a model potato matrix and 135 µg/kg acrylamide for Russet Norkotah. The lower limit of quantification was 200 µg/kg. A manuscript describing this work was submitted. A method to use NIRS to quickly quantify tuber dry matter and sugar contents is being developed. Objective 3. QTL analysis of data from 43 russet clones developed and genotyped under the AFRI-funded SolCAP project is continuing. Traits examined included tuber shape, tuber solids, tuber sugars and acrylamide content in fried strips prepared after 6 months storage at 45?F. Progeny of a cross between two low-asn clones were planted in MI in 2014 and 2015 to obtain tubers for asn and chip processing analysis. Lines with good chip-processing quality and with higher and lower asn will be tested for influence of asn on chip acrylamide content. Methods for genotyping potato by next-generation sequencing and computational methods for genome wide association studies using tetraploid potato were developed. Methods were validated using data from the SolCAP study. Objective 4. Experiments were conducted to determine consumer's willingness to pay for low acrylamide potato products including products achieved using biotechnology. Various information statements relevant to acrylamide were provided to participants. The price that consumers were willing to pay depended strongly on the information provided to them. A manuscript describing the key findings is being revised. Objective 5. Commercial seed growers working

under contract with this project produced seed tubers for AF4296-3, Dakota Russet, AC96052-1RU, and A02507-2LB. Seed were used for the 2015 SCRI Agronomic trial, and industry agronomic trials in WA, ID, WI, ND, ME, and NB. Approximately 10,000 pounds of Dakota Russet seed were provided to a cooperating fry processor for use in a large-scale trial. Addition seed tubers of A02507-2LB and AF4296-3 were replanted to generate seed for industry use in 2016. SCRI Agronomic Trials were conducted with 7-10 lines in WA, OR, ID, MN, WI and ME. Clones were quantified for tuber yield, size profile, specific gravity, defects, and tuber quality. Fries prepared at the USDA Facility in East Grand Forks were used for quality, acrylamide and consumer attribute testing. Tubers were also assayed for sugar content, fry quality and weight loss over time at the Kimberly Potato Storage Research Facility. These data were provided to industry and contribute to assessments of a line's ability to succeed in commercial production. Agronomic and physiological responses to in-season nutrient applications were evaluated for medium- and low-acrylamide lines identified in Objective 1. In WA, Clearwater Russet, Dakota Russet, A02424-83LB, A03158-2TE and A06084-1TE were evaluated to establish yield responses and effects on physiological maturity to 4 levels of nitrogen (N). How N-induced differences in tuber maturity affected retention of process quality was determined for Dakota Russet and Clearwater Russet over 250 days of storage. In MN, responses of Easton and Dakota Russet to N-rate relative to the standard variety Russet Burbank were examined. Results from the first two years of this trial were provided to growers. In ME, N-rate responses of Easton and AF4296-3 were compared to Russet Burbank. Tuber size increased with increasing N-rate, while specific gravity declined. Fry color at the December sampling became darker as N-rate increased; however, by March there was little remaining effect of N-rate on fry color. This trial is being repeated in 2015. Russet Burbank, Clearwater Russet, AF4296-3, and Dakota Russet were evaluated in ID at 4 N-rates. The lower N treatment produced tubers with higher glucose levels in storage. This trial is being repeated in 2015. Semi-commercial storage trials were conducted to evaluate performance of clones with high priority to industry. Chip varieties Waneta, Pinnacle, and Lelah and fry processing variety W6234 were evaluated in bulk-storage bins at the Wisconsin Storage Research Facility. Waneta and Pinnacle maintained outstanding chip quality well into 2015. Project researchers in ME collaborated with McCain Foods to conduct a semi-commercial storage bin study of Easton. Easton was stored until April with little loss to disease and much better fry color and uniformity than Russet Burbank. Retention of process quality was evaluated for WA SCRI Agronomic trial entries. AO2507-2LB, POR06V12-3 and AO2138-2 were evaluated for tuber tolerance to heat stress. A similar study with A03141-6, A02507-2LB and Clearwater Russet is currently in progress. Clones and cultivars from the WA 2014 Late Season Regional Russet Trial were screened for tuber asn and those resistant to low temperature sweetening following 60 days storage at 40oF, 44oF, and 48oF were identified. Similar analyses will be conducted in 2015.

PUBLICATIONS: 2014/09/01 TO 2015/08/31

1. Type: Journal Articles Status: Published Year Published: 2015 Citation: Wang, Y., Bethke, P.C., Bussan, A.J., Glynn, M.T., Holm, D.G., Navarro, F.M., Novy, R.G., Palta, J.P., Pavek, M.J., Porter, G.A., Sathuvalli, V.R., Thompson, A.L., Voglewede, P.J., Whitworth, J.L., Parish, D.I., and Endelman, J.B. (2015). Acrylamide-forming potential and agronomic properties of elite U.S. potato germplasm from the National Fry Processing Trial. Crop Sci. doi: 10.2135/cropsci2015.03.0173.
2. Type: Journal Articles Status: Published Year Published: 2015 Citation: Wang, Y., Bethke, P.C., Drilias, M.J., Schmitt, W.G., and Bussan, A.J. (2015). A multi-year survey of stem-end chip defect in chipping potatoes (Solanum tuberosum L.). Amer. J. Potato Res. 92: 79-90.
3. Type: Journal Articles Status: Published Year Published: 2015 Citation: Zhu, X., Gong, H.L., He, Q.Y., Zeng, Z.X., Busse, J.S., Jin, W.W., Bethke, P.C., and Jiang J.M. (2015). Silencing of vacuolar invertase and asparagine synthetase genes and its impact on

acrylamide formation of fried potato products. Plant Biotech. J. doi: 10.1111/pbi.12421.
4. Type: Conference Papers and Presentations Status: Accepted Year Published: 2015 Citation: Bethke, P.C. (2015). Progress and success of the SCRI Acrylamide project. Proceedings of the 99th Annual Meeting of the Potato Association of America. (in press).
5. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Gause, K., Porter, G.A., Perkins, L.B. and Camire, M.E. (2015). Nitrogen rate effects on potato yield, quality, and acrylamide-forming potential. Amer. J. Potato Res. 92: 190.
6. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Gause, K., Porter, G.A., Perkins, L.B., and Camire, M.E. (2015). Potassium rate effects on potato yield, quality, and acrylamide-forming potential. Amer. J. Potato Res. 92: 190.
7. Type: Conference Papers and Presentations Status: Accepted Year Published: 2015 Citation: Herman, D.J., L.O. Knowles, L.O., and N.R. Knowles, N.R. (2015). Screening sweetening-resistant clones for tolerance to heat stress. Proceedings of the 99th Annual Meeting of the Potato Association of America. (in press).
8. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Knowles, N.R. and Pavek. M.J. (2015). WSU potato cultivar yield and postharvest quality evaluations for 2014. Washington State University Special Report. 116 pages.
9. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Knowles, N.R., Pavek, M.J., and Knowles, L.O. (2015). Nitrogen modulates physiological maturity and tuber N content to affect post harvest processing and nutritional qualities. Proceedings of the 98th Annual Meeting of the Potato Association of America. Am. J. Pot. Res 92: 196.
10. Type: Conference Papers and Presentations Status: Accepted Year Published: 2015 Citation: Knowles, N.R., Pavek, M.J., and Knowles, L.O. (2015). Developmental profiles, nitrogen use and post harvest quality of Alpine & Sage Russet Potatoes in the Columbia Basin. Annual Washington and Oregon Potato Conference, Jan. 27-30, Kennewick, WA. (in press).
11. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Knowles, N.R., Pavek, M.J., Fuller, N., and Knowles, L.O. (2014). Post harvest quality of new clones and cultivars. In Washington State Potato Commission Progress Reports for the year 2013, 22 pp.
12. Type: Conference Papers and Presentations Status: Accepted Year Published: 2015 Citation: Ocaya, P.C., Gause, K., and Porter, G.A. (2015). Nitrogen rate response of Russet Burbank and four new fry processing varieties. Am. J. Potato Res. (in press).
13. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Pavek, M.J. and Knowles, N.R. (2014). WSU potato cultivar yield and postharvest quality evaluations for 2013. Washington State University Special Report. 110 pages.
14. Type: Conference Papers and Presentations Status: Accepted Year Published: 2015 Citation: Porter, G.A., Ocaya, P.C., and Mills, T. (2015). Easton: A new potato variety for fry processing that has excellent fried-product color and resistance to hollow heart and Verticillium wilt. Am. J. Potato Res. (in press).
15. Type: Conference Papers and Presentations Status: Accepted Year Published: 2016 Citation: Rosen, C.J., Sun, N., Olsen, N., Thornton, M.K., Knowles, N.R., Knowles, L.O., and Pavek, M.J. (2016). Impact of agronomic and storage practices on acrylamide. Proceedings of the 99th Annual Meeting of the Potato Association of America. (in press).
16. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Sun, N., Rosen, C., Crants, J., and McNearney, M. (2015). A two-year evaluation of new potato genotypes for tuber yield, quality, and low reducing sugars. Proceedings from the Minn. Area II Potato Research and Promotion Council and the Northern Plains Potato growers Asscn. 178-191.
17. Type: Conference Papers and Presentations Status: Published Year Published: 2015

Citation: Sun, N., Rosen, C., Crants, J., Thompson, A., and Glynn, M. (2015). Tuber yield and acrylamide concentration of chips and fries as affected by nitrogen management cultivar and storage time. Amer. J. Potato Res. 92: 209.
18. Type: Conference Papers and Presentations Status: Accepted Year Published: 2016 Citation: Wang, Y., Endelman, J., and Bethke, P.C. (2016). A national effort to identify fry processing clones with low acrylamide-forming potential. Proceedings of the 99th Annual Meeting of the Potato Association of America. (in press).
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21. Type: Other Status: Published Year Published: 2014 Citation: Adedipe, O., Johanningsmeier, S., Yencho, C., and Truong, V.D. (2015). Development of a near infrared (NIR) model for prediction of acrylamide content in French-fried potatoes. Poster presented at the 248th National meetings and Exposition of the American Chemical Society (ACS), San Francisco, CA. August 10-14, 2014.
22. Type: Other Status: Published Year Published: 2015 Citation: Bethke, P.C. (2015). Genetic and cultural management solutions to improve potato storage quality. Wisconsin`s Annual Potato Meeting. February 3, 2015.
23. Type: Other Status: Published Year Published: 2015 Citation: Bethke, P.C. (2015). SCRI Acrylamide program update. SCRI Acrylamide Advisory Committee meeting at Potato Expo, January 7, 2015.
24. Type: Conference Papers and Presentations Status: Accepted Year Published: 2016 Citation: Wiberley-Bradford, A., Busse, J.S., and Bethke, P.C. (2016). Heat stress during development alters post-harvest sugar contents and chip processing quality of potato tubers. Proceedings of the 99th Annual Meeting of the Potato Association of America. (in press).
25. Type: Conference Papers and Presentations Status: Accepted Year Published: 2016 Citation: Wiberley-Bradford, A., Busse, J.S., and Bethke, P.C. (2016). Regulation of sugar metabolism in wild-type and low-invertase transgenic chipping potatoes during and after cooling for low-temperature storage. Proceedings of the 99th Annual Meeting of the Potato Association of America. (in press).
26. Type: Theses/Dissertations Status: Published Year Published: 2015 Citation: McFadden, J. (2015). Essay on Climate Change Adaptation and Biotechnologies in US Agriculture. Ph.D. Dissertation, Iowa State University.
27. Type: Other Status: Published Year Published: 2015 Citation: Brandt, T., Olsen, N., and Thornton, M. (2015). Effects of Nitrogen Fertilizer Management on Post-harvest Performance of Russet Burbank and Three Low Acrylamide Potato Clones. The Potato Association of America Meeting, Portland, ME, July 21, 2015.
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30. Type: Other Status: Published Year Published: 2015 Citation: Huffman, W.E. and Lacy, K. (2015). Consumer demand for potato products and willingness-to-pay for low-acrylamide, sulfite-free, fresh potatoes and dices: evidence from lab auctions. Presented at the American Association of Wine Economists, Mendoza, Argentina, May 26-30, 2015.

31. Type: Other Status: Published Year Published: 2015 Citation: Huffman, W.E. (2015). Consumer?s willingness to pay for low acrylamide potato products. SCRI Acrylamide Advisory Committee meeting at Potato Expo, January 7, 2015.
32. Type: Other Status: Published Year Published: 2015 Citation: Knowles, N.R., Herman, D., Pavek, M.J., Knowles, L.O., Dean, C., and Ellis, G. (2015). Searching for heat, water and nitrogen stress tolerance. WSU Annual Potato Field Day, IAERC, Othello, WA, June 25.
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38. Type: Other Status: Published Year Published: 2015 Citation: Rosyara, U. and Endelman, J.B. (2015). Genome-wide association studies for autopolyploids - potato. Plant and Animal Genome XXIII. San Diego, CA January 10-14, 2015.
39. Type: Other Status: Published Year Published: 2015 Citation: Shelley, J., and Bethke, P. (2015). Germplasm development and phenotyping. Hancock Agricultural Research Station Annual Potato Field Day, July 15, 2015.
40. Type: Other Status: Published Year Published: 2015 Citation: Thorton, M., Olsen, N., and Novy, R. (2015). Agronomic and storage characteristics of new low acrylamide lines. 47th Annual Idaho Potato Conference. Pocatello, ID, January 21, 2015.
41. Type: Other Status: Published Year Published: 2014 Citation: Novy, R. (2014). Update on Research (including breeding for lower acrylamide) in the USDA-ARS Potato Breeding and Plant Pathology Program-Aberdeen, ID. NCCC215 Potato Breeding and Genetics Technical Committee Meeting. Chicago, IL. December 9, 2014.
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43. Type: Other Status: Published Year Published: 2015 Citation: Ocaya, P.C., Gause, K., and Porter, G.A. (2015). Nitrogen Rate Response of Russet Burbank and Four New Fry Processing Varieties. Presentation at the 99th Annual Meeting of the Potato Association of America, Portland, ME. July 22, 2015.
44. Type: Other Status: Published Year Published: 2014 Citation: Olsen, N., Peck, S., Woodell, L., Brandt, T., and Frazier, M.J. (2014). University of Idaho Potato Storage Research and Extension Program. Kimberly Potato Storage Advisory Committee Meeting, Kimberly, ID, November 13, 2014.
45. Type: Other Status: Published Year Published: 2015 Citation: Olsen, N., Stark, J., and Novy, R. (2015). Managing Clearwater, Teton and other new varieties. 47th Annual Idaho Potato Conference. Pocatello, ID, January 21, 2015.

46. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A. (2015). Potato breeding and variety development. Presentation to Vice President Ward?s Maine Legislative VIP Tour Group, University of Maine, January 14, 2015, Orono, ME.
47. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A. (2015). New potato varieties, upcoming releases and licensing opportunities. Presentation to the Maine Potato Board and University of Maine Potato Variety Release Advisory Committee, February 11, 2015, Presque Isle, ME.
48. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A. and Ocaya, P. (2015). Progress report on new potato variety challenge grant program and potato variety research - 2014 Growing Season. Presentation to the Maine Potato Board Research Subcommittee, February 11, 2015, Presque Isle, ME.
49. Type: Other Status: Published Year Published: 2015 Citation: Porter, G.A., Ocaya, P., and Mills, T. (2015). New candidate potato varieties from the Maine Potato Breeding Program. Presentation at the University of Maine Cooperative Extension Potato Conference, Caribou, ME. January 21, 2015.
50. Type: Other Status: Published Year Published: 2014 Citation: Wang, Y. (2014). Collaboration between universities and industry to solve the potato acrylamide problem. ASA, CSSA, SSSA International annual meeting. Long Beach CA, November 2-5 2014.
51. Type: Other Status: Published Year Published: 2015 Citation: Wang, Y., Endelman, J., and Bethke, P. (2015). A national effort that helps improve food safety of potato products. American Society of Horticultural Science. New Orleans LA, August 4-7, 2015.
52. Type: Other Status: Published Year Published: 2015 Citation: Wang, Y., Endelman, J., and Bethke, P.C. (2015). SCRI Agronomic trial update and NFPT data analysis. NFPT Field day, East Grand Forks MN, October 13-14, 2015.
53. Type: Other Status: Published Year Published: 2015 Citation: Wang, Y., Zhu, X., Endelman, J.B., Jiang, J.M., and Bethke, P.C. (2015). A nationally coordinated effort to mitigate food safety concerns related to acrylamide in fried potato products though identification of superior germplasm. American Society of Plant Biologists annual meeting, Minneapolis, MN. July 26-30, 2015.
54. Type: Other Status: Published Year Published: 2015 Citation: Wiberley-Bradford, A., Busse, J.S., and Bethke, P.C. (2015). Heat stress during development alters post-harvest sugar contents and chip processing quality of potato tubers. American Society of Plant Biologists annual meeting, Minneapolis, MN. July 26-30, 2015.
55. Type: Other Status: Published Year Published: 2015 Citation: Wiberley-Bradford, A., Busse, J.S., and Bethke, P.C. (2015). Regulation of sugar metabolism in chipping potatoes during and after cooling for low-temperature storage. Poster presented at American Society of Plant Biologists annual meeting, Minneapolis, MN. July 26-30, 2015.
56. Type: Other Status: Published Year Published: 2014 Citation: Zhu, X., Wiberley-Bradford, A., Busse, J.S., Craig, R., Jiang, J.M., Bethke, P.C. (2014). Vacuolar invertase activity is a key determinant of chip and fry processing quality of potato. 2014 Obihiro University and University of Wisconsin Potato Research Workshop, Obihiro, Japan, November 12, 2014.

PROGRESS: 2013/09/01 TO 2014/08/31
Target Audience: The ultimate goal of this project is to develop and select potato cultivars that can be processed to potato chips and french fries with reduced amount of acrylamide. Thus, consumers, potato growers, the potato processing industry and geneticists working with potato will benefit from this research project. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Nine undergraduate students, 10 graduate students and 7 post-doctorate fellows were supported by this grant during the current reporting period. This project provides an excellent environment for training in comprehensive, cross-disciplinary research and extension activities. Students and post-doctorate fellows have received training in such diverse areas

as traditional and molecular plant breeding, crop nutrient management, crop modeling, food science, molecular biology, and statistical analysis. Trainees have benefited from interactions with industry partners including commercial growers, field agronomists and raw product managers, food scientists and representatives of finished product customers. How have the results been disseminated to communities of interest? Results have been disseminated through regular meetings, calls and emails with leadership of the U. S. potato industry, and through presentations to and discussions with the larger community of stakeholders locally and nationally. Activities during this reporting period include providing a four-hour presentation to the project Advisory Committee and interested parties at the National Potato Council's Potato Expo. Additional presentation were made at Potato Expo, multiple grower education conferences, at the National Potato Council's summer meeting, the US potato Board's summer meeting, the Potato Association of America annual meeting, several regional field days, the National Fry processing Trial field day, the NFPT variety selection meeting, the NCCC215 plant breeding meeting and others. Information was also disseminated though the project website and posting results from the National Chip Processing Trial and National Fry Processing Trial to online databases. Several articles highlighting ongoing activities were published in trade journals. What do you plan to do during the next reporting period to accomplish the goals? During the next reporting period, we will continue to build on the success that we have had during that past year. Continued dialog and engagement with industry remains a priority. We believe that we are on track to accomplish the goals established for the project. As additional data are generated and evaluated by project participants and members of industry, we expect that there will be some adjustment of activities to take full advantage of opportunities that arise, or to shift resources from areas where progress has been more rapid than expected. As an example, we have committed available resources to extend grant-funded activities in the National Fry Processor Trial. This trial was prioritized because fries contribute the largest percentage of acrylamide to the U.S. diet, and data gathered so far indicate that substantial acrylamide reductions in fries may be achievable by using newly developed clones. We are also focusing additional resources on computational tools for the analysis of genetic data, as a way of increasing our capacity to do molecular breeding in potato. This change in emphasis is strongly supported by the processing industry. Improved tools for rapid phenotyping of high value potato traits are needed, and we have initiated research in the area of rapidly quantifying specific gravity distribution in raw tubers. Industry specialist have impressed upon researchers that specific gravity distribution is a highly desirable tuber quality trait for fry processing. Until now, this trait has not been evaluated routinely by potato breeding programs.

IMPACT: 2013/09/01 TO 2014/08/31
What was accomplished under these goals? Objective 1. This SCRI project is integrated with the industry-driven National Fry Processor Trial (NFPT), National Chip Processor Trial (NCPT) and US Potato Board (USPB)-Snack Food Association (SFA) trial. NFPT sites in WI and ME were funded by this SCRI project in 2013 and 2014. Industry funded sites in WA, ID and ND. All sites grew a common set of advanced clones selected by project researchers, potato breeders and representatives of industry. 77 entries and standard varieties Russet Burbank and Ranger Russet were planted in 2013 and followed in storage until July. 68 clones were planted in 2014. Tubers were sent to the USDA Worksite in East Grand Forks, MN for inspection by industry participants. Sugar and asparagine (asn) content of tubers and acrylamide content in finished fries was quantified at multiple times. Select clones were processed into fries and evaluated for consumer attributes by JR Simplot (samples from WA, ID, and ND) and McCain Foods (samples from WI and ME). Technical staff at each location prepared a report describing consumer attribute data. A database containing key information for each NFPT clone was updated and expanded. Many NFPT clones produced fries with lower contents of acrylamide than standard varieties. NFPT lines with high

potential for commercial success were entered into replicated SCRI Agronomic trials as described in Objective 5. The NCPT evaluated approximately 200 early generation clones in non-replicated trials at 11 locations in 2013 and 2014. Activities in OR were funded by this SCRI project and industry funded the other sites. Clones were evaluated for tuber appearance, sugar content, chip color, and specific gravity. Clones with high potential for commercial interest were advanced to the USPB SFA trial. That trial had 18 clones at 11 locations in 2013-2014. The OR site was funded by this project. Clones from the USPB SFA trial with greatest potential for meeting industry goals were processed into chips at commercial plants operated by project cooperators and used for taste tests and acrylamide determinations. Taste test data show few differences between established varieties and new clones. Accumulating data indicate the new chipping potato varieties do not have lower acrylamide-forming potential than standard varieties, except during late storage. Objective 2. Acrylamide data generated in Objective 1 were used by potato breeders to select lower-acrylamide parents for use in crosses. True potato seed were produced for seedling tuber production in 2014 and 2015, with subsequent field selection beginning in 2015. Seed tubers of Russet Burbank lines with a range of vacuolar invertase and asn synthetase gene expression as a result of silencing by RNA-interference were planted in the field. Most lines exhibited normal growth above ground. Harvested tubers will be used for detailed molecular and biochemical analyses to determine effects of invertase silencing and/or asn synthetase silencing on yield, tuber reducing sugars and asn content, and acrylamide-forming potential. Maintenance of low tuber reducing sugar contents is a prerequisite for producing processed potato products with low amounts of acrylamide. Research was initiated to investigate how an extended preconditioning period and slow cooling, as are commonly done in industry, affect tuber reducing sugar contents relative to rapid cooling, which is common in laboratory-based studies. Progress was made on implementation of near-infrared spectroscopy (NIR) as a method to rapidly predict the concentration of acrylamide in french-fried potatoes and potato chips. However, the range of detection is still about 200 ppb. Additional work has explored the possibility of using NIR to quickly quantify tuber dry matter content and sugar contents. Initial data are encouraging, and this area of research is being explored in more detail. Objective 3. Tubers of 43 clones from the russet mapping population developed and genotyped under the AFRI-funded SolCAP project were grown in 2013 stored at 45F for 6 months. Fried strips were processed and assayed for acrylamide. The correlation between 2012 and 2013 acrylamide data was high (0.85) and the correlation between ID and MI was good (0.67). On the other hand, the correlation between acrylamide and tuber asn content was not significant. The MSB699 breeding population, which was generated by crossing two low-asn clones identified earlier in the project, was planted in MI in 2014 to obtain tubers for further asn analysis. QTL analysis will follow. Methods for genotyping potato by next-generation sequencing and computational methods for genome wide association studies using tetraploid potato are being developed. Validation studies are using data from the AFRI SolCAP study. Objective 4. Experiments were conducted to determine consumer's willingness to pay for low acrylamide potato products. These experiments used authentic food products in lab auctions, including low-acrylamide potato products achieved using biotechnology provided by cooperator JR Simplot. Participants bid on whole potatoes, potato chips and frozen French fries. Various combinations of information statements relevant to acrylamide in potato products including, (i) a scientific perspective on human exposure to acrylamide, (ii) an environmental group's (negative) perspective on biotechnology, and (iii) a potato industry perspective (positive) on reducing acrylamide in potato products by using biotechnology methods, were provided to participants to determine how information influenced willingness to pay. Experiments were conducted in Des Moines, LA and Boston in early summer 2014 with a total of 304 participants. Objective 5. First field year seed tubers for AF4296-3, Dakota Russet (ND8229-3), AC96052-1RU, and A02507-2LB were produced by commercial seed growers working under contract with this SCRI project. Additional SCRI project-produced mini tubers of

AF4296-3 were increased in the field by a ME seed grower in 2014. SCRI Agronomic Trials were conducted with 9 lines in WA, OR, ID, MN, and WI and with 7 lines in ME. Clones were quantified for tuber yield, size profile, specific gravity, defects, and tuber quality. Staff at the USDA Facility in East Grand Forks prepared French fries from each clone that were used for quality evaluations and subsequent acrylamide and consumer attribute testing. Tubers were assayed for sugar content, fry quality and weight loss over time at the Kimberly Potato Storage Research Facility. These data were provided to industry and contribute to assessments of a line's ability to succeed in commercial production. Agronomic and physiological responses to in-season nitrogen applications were evaluated for two low-acrylamide lines identified in Objective 1, AF4296-3 and Dakota Russet (ND8229-3), in a replicated trial in ID. Similar trials were conducted in WA with Dakota Russet, A02424-83LB, A03158-2TE and A06084-1TE, and in ME with Easton (AF3001-6) and AF4296-3. Samples were evaluated for vine and tuber growth, tuber size, specific gravity and tuber sugar contents. Tubers from the ID site were transported to the Kimberly Potato Storage Research Facility for evaluation of fry color and quality, sugar concentrations, weight loss, dormancy break, and Fusarium dry rot susceptibility. Semi-commercial storage trials were conducted to evaluate performance in storage of clones with high priority to industry. Chip varieties Waneta, Pinnacle, and Lelah along with fry processing variety W6234 are being evaluated for storage quality in bulk-storage bins at the Wisconsin Storage Research Facility. Project researchers in ME are collaborating with McCain Foods USA to conduct a semi-commercial storage bin study of Easton (AF3001-6) at the Aroostook Research Farm. These trials provide an early assessment of how well these new varieties hold up in storage.

PUBLICATIONS: 2013/09/01 TO 2014/08/31

1. Type: Journal Articles Status: Published Year Published: 2014 Citation: Bethke, P.C. 2014. Ethylene in the atmosphere of commercial potato (Solanum tuberosum) storage bins and potential effects on tuber respiration rate and fried chip color. American Journal of Potato Research 91: 688-695.
2. Type: Journal Articles Status: Published Year Published: 2014 Citation: Wiberley-Bradford, A.E., J.S. Busse, J.M. Jiang, and P.C. Bethke. 2014. Sugar metabolism, chip color, invertase activity, and gene expression during long-term cold storage of potato (Solanum tuberosum) tubers from wild-type and vacuolar invertase silencing lines of Katahdin. BMC Research Notes 7: 801.
3. Type: Journal Articles Status: Published Year Published: 2014 Citation: Zhu, X., C. Richael, P. Chamberlain, J.S. Busse, A.J. Bussan, J.M. Jiang, and P.C. Bethke. 2014. Vacuolar invertase gene silencing in potato (Solanum tuberosum L.) improves processing quality by decreasing the frequency of sugar-end defects. PLoS ONE 9: e93381.
4. Type: Journal Articles Status: Published Year Published: 2014 Citation: Zommick, D.H., L.O. Knowles, M.J. Pavek, and N.R. Knowles. 2014. In-season heat stress compromises postharvest quality and low temperature sweetening resistance in potato (Solanum tuberosum L.). Planta 239: 1243-1263.
5. Type: Book Chapters Status: Published Year Published: 2014 Citation: Jansky, S.H., D.M. Spooner, and P.C. Bethke. 2014. Yield Gains in Potato: Contributing Factors and Future Prospects. In: Yield Gains in Major U.S. Field Crops: Contributing Factors and Future Prospects, Stephen Smith, Brian Diers, James Specht, and Brett Carver, eds, Crop Science Society of America, Madison, WI.
6. Type: Theses/Dissertations Status: Published Year Published: 2014 Citation: Gause, K. 2014. Effect of Nitrogen and potassium on potato yield, quality, and acrylamide-forming potential. M.S. Thesis, University of Maine.
7. Type: Other Status: Published Year Published: 2014 Citation: Wiberley-Bradford, A., X.B. Zhu, J.M. Jiang, and P.C. Bethke. 2014. Looking ahead?How biotechnology may change potato storage. The Badger Common?Tater. 66: 11-12.
8. Type: Other Status: Published Year Published: 2014 Citation: Wiberley-Bradford, A. and

P.C. Bethke. 2014. The curse of invertase. Spudman 52: 22-23.
9. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Adedipe, O., S. Johanningsmeier, V.D. Truong, D. Douches, J. Coombs, M. Clough, and C. Yencho. 2014. Near infrared spectroscopy method for quantification of acrylamide in processed potato products. 98th Annual Meeting of The Potato Association of America, Spokane, WA. July 27-31, 2014. (poster)
10. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Adedipe, O., S. Johanningsmeier, C. Yencho, and V.D. Truong. 2014. Development of a near infrared (NIR) model for prediction of acrylamide content in French-fried potatoes. 248th National meetings and Exposition of the American Chemical Society (ACS), San Francisco, CA. August 10-14, 2014. (poster)
11. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Bethke, P.C. 2014. Development of potatoes for reduced acrylamide production during cooking. Food Research Institute annual meeting, Madison, WI, May 21-22, 2014.
12. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Bethke, P.C. 2014. The SCRI acrylamide project. National Potato Council Summer Meeting. Sun Valley ID. June 24-25, 2014.
13. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Bethke, P.C. 2014. Variety development for chip and fry processing: One size does not fit all. Wisconsin Seed Potato Improvement Association annual meeting, Antigo, WI, February 12, 2014.
14. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Bethke, P.C. 2014. NFPT and SCRI project update. NFPT Field Day, East Grand Forks, MN, October 14-15, 2014.
15. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Bethke, P.C. 2014. New variety development for the frozen process industry: this time really is different. National Potato Council Potato Expo, San Antonio, TX, January 8-10, 2014.
16. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Bussan, A.J. and P.C. Bethke. 2014. SCRI Advisory Committee meeting. National Potato Council Potato Expo, San Antonio, TX, January 8-10, 2014.
17. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Jansky, S.H., D. Douches, J. Endelman, J. Coombs, and N. Manrique. 2014. Developing resources for diploid potato breeding and genetics. The 11th Solanaceae Conference, Porto Segura ? Bahia, Brazil, November 2-6, 2014.
18. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Novy, R. 2014. National Fry Processing Trial update. 46th Annual Idaho Potato Conference. Pocatello, ID, January 22, 2014.
19. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Novy, R. 2014. A02507-2LB and A03158-2TE: Promising breeding clones from the northwest (Tri-state) potato variety development program. 98th Annual Meeting of the Potato Association of America. Spokane, WA, July 31, 2014.
20. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Olsen, N. 2014. Storage Highlights. 46th Annual Idaho Potato Conference. Pocatello, ID, January 22, 2014.
21. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Olsen, N. 2014. University of Idaho Project Update. IACI Executive Committee Meeting, 86th Annual Idaho Grower Shippers Association Convention, Sun Valley, ID. August 27, 2014.
22. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Olsen, N., S. Peck, L. Woodell, T. Brandt, and M.J. Frazier. 2014. University of Idaho Potato Storage Research and Extension Program. Kimberly Potato Storage Advisory Committee Meeting, Kimberly, ID, November 13, 2014.

23. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Porter, G.A. and P.C. Ocaya. 2014. Breeding and Developing New Potato Varieties, National fry processing trials and USPB/SFA chipping potato trials. Presentation at the University of Maine Aroostook Research farm Field Day, Presque Isle, ME. August 13, 2014.
24. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Wang, Y., A.J. Bussan, P.C. Bethke, and D. Parish. 2014. Update on National Fry Processor Trial (NFPT) and SCRI Acrylamide Project. We are Ready for 2014. National Potato Council Potato Expo, San Antonio, TX, January 8-10, 2014. (Poster)
25. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Wang, Y. A.J. Bussan, P.C. Bethke, and D. Parish. 2014. ASA-CSSA-SSSA International Annual Meeting. Long Beach, CA, November 3-6, 2014.
26. Type: Conference Papers and Presentations Status: Published Year Published: 2014 Citation: Wang, Y., P.C. Bethke, and A.J. Bussan. 2014. SCRI Acrylamide Project Update. Wisconsin?s Annual Potato Meeting. February, 2014.

PROGRESS: 2012/09/01 TO 2013/08/31
Target Audience: The ultimate goal of this project is to develop and select potato cultivars that can be processed to potato chips and french fries with reduced amount of acrylamide. Thus, potato growers and the potato processing industry will be benefited form this research project. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Four high school students, 7 undergraduate students, 10 graduate students and 3 post-doctorate fellows were supported by this grant during the current reporting period. This project provides an excellent environment for training in comprehensive, cross-disciplinary research and extension activities. Students and post-doctorate fellows have received training in such diverse areas as traditional and molecular plant breeding, crop nutrient management, crop modeling, food science, molecular biology, and statistical analysis. Trainees have benefited from interactions with industry partners including commercial growers, field agronomists and raw product managers, food scientists and representatives of finished product customers. How have the results been disseminated to communities of interest? Results have been disseminated through regular meetings, calls and emails with leadership of the U. S. potato industry, and through presentations and discussions with the larger community of local and national stakeholders locally. Activities during this reporting period include providing a four-hour presentation to the project Advisory Committee and interested parties at the National Potato Council's Potato Expo. Additional presentations were made at multiple grower education conferences, at the National Potato Council's summer meeting, the US potato Board's summer meeting, the Potato Association of America annual meeting, several regional field days, the National Fry processing Trial field day, the NFPT variety selection meeting, the NCCC84 plant breeding meeting and others. Information was also disseminated though creation of a project website and posting results from the National Chip Processing Trial and National Fry processing trial to online databases. A comprehensive review article on acrylamide in processed potato products was written by Co-PIs and published, as were several articles in trade journals. What do you plan to do during the next reporting period to accomplish the goals? During the next reporting period, we will continue to build on the success that we have had during that past year. We believe that we are on track to accomplish the goals established for the project. As additional data are generated and evaluated by project participants and members of industry, we expect that there will be some adjustment of activities to take full advantage of opportunities that arise, or to shift resources from areas where progress has been more rapid than expected. As an example, we anticipate a greater emphasis in the coming year on research for low asparagine content in tubers used for potato chips, because the data collected so far indicate that this may be required to make substantial improvements in chip acrylamide content. We are focusing additional resources on computational tools for the analysis of genetic data, as a way of

increasing our capacity to do molecular breeding in potato. This change in emphasis is strongly supported by the processing industry. Improved tools for rapid phenotyping of high value potato traits are needed, and we have initiated new research in this area.

IMPACT: 2012/09/01 TO 2013/08/31
What was accomplished under these goals? Objective 1. This SCRI project is integrated with the industry-driven National Fry Processor Trial (NFPT), National Chip Processor Trial (NCPT) and US Potato Board (USPB)-Snack Food Association (SFA) trial. NFPT sites in WI and ME were supported by this SCRI project in 2012 and 2013, and industry funded sites in WA, ID and ND. All sites grew a common set of advanced potato clones selected by project researchers, potato breeders and representatives of the fry processing industry. 86 clones and standard varieties Russet Burbank and Ranger Russet were planted in 2012 and followed in storage until July 2013. 77 clones were planted in 2013. Tubers were shipped to the USDA Worksite in East Grand Forks, MN for inspection by industry participants. Sugar and asparagine (asn) content of tubers and acrylamide content in finished fries was quantified at multiple times. Select clones were processed into fries and evaluated for consumer attributes by JR Simplot in Caldwell, ID. JR Simplot technical staff prepared a report describing consumer attribute data. A database containing key information for each NFPT clone was designed and implemented by SCRI project participants. The most promising NFPT lines were entered into replicated SCRI Agronomic trials at multiple locations as described in Objective 5. The NCPT evaluated approximately 200 early generation clones in non-replicated trials at 11 locations in 2012 and 2013. Activities in OR were funded by this SCRI project and industry funded the other sites. Clones were evaluated for tuber appearance, sugar content, chip color, and specific gravity. Clones with high potential for commercial interest were advanced to the USPB SFA trial. That trial had 16 clones at 13 locations in 2012-2013. The OR site was supported by this project. Clones from the USPB SFA trial with greatest potential for meeting industry goals were processed into chips at commercial plants, and operated by project cooperators and used for taste tests and acrylamide determinations. Taste test data are highly encouraging. Panelists were unable to taste differences between established varieties and new clones in most cases. Objective 2. Acrylamide data generated in Objective 1 were used to select lower-acrylamide parents, such as A02507-2LB, that were used in crosses by potato breeding programs. True potato seed were produced for seedling tuber production in 2013 and 2014, with subsequent field selection beginning in 2014. RNA-interference (RNAi) was used to produce low-invertase, low-asn synthetase lines of Atlantic and Russet Burbank that will be used for research studies. These lines are expected to have a range of tuber reducing sugars and asn contents and will have high utility for creating predictive models of acrylamide content of products based on precursor content in tubers. Existing low-invertase RNAi lines of Atlantic, MegaChip and Dakota Pearl were evaluated in 2012-2013 for tuber processing quality and for expression of genes for key enzymes of carbohydrate metabolism in potato tubers. Ongoing analysis of these data show that silencing the vacuolar acid invertase gene had little to no effect on the expression of other genes in the starch-to-sugar pathway in potatoes, wich added to our understanding of acrylamide-precursor formation. An evaluation of near-infrared spectroscopy (NIR) for low-cost quantification of acrylamide in finished products was initiated. Protocols were established for potato sample preparation and acrylamide quantification by NIR. Initial results showed that NIR could quantify purified acrylamide in an aqueous solution and a potato-water matrix. The limit of quantification for acrylamide was determined to be approximately 200 ppb. Objective 3. Forty three clones from the russet mapping population developed and genotyped under the AFRI-funded SolCAP project were planted in replicated plots in ID and MI in 2012 and 2013 and stored at 45F for 6 months. This population segregated for french fry quality, as well for acrylamide content in processed fries. Phenotype data will be used to confirm single nucleotide polymorphism (SNP) marker associations for key fry processing traits. A previously-

genotyped chip mapping population (MSV507, Tundra x Kalkaska) was evaluated for a second year. Harvested tubes were stored at 45F and chip-processed to determine acrylamide-forming potential and key agronomic traits. Tubers were found to have a range of asn contents (3-14 mg/g). QTL analysis revealed a QTL on chromosome 7 for tuber asn that explains 26% of the phenotypic variation. A major QTL for chip-processing color that explains 35% of the phenotypic variation was identified on chromosome 4. In order to test the hypothesis that low tuber asn content is a trait that can be bred for effectively using conventional breeding, two low-asn lines identified in the MSV507 population were crossed. Tubers from the resulting population (MSB699) were assayed for asn content. Three lines had less asn in tubers than both parental lines, and the overall population distribution was skewed towards lower amounts of asn. Thus, we may be able to use conventional breeding to develop new potato varieties with low tuber asn and, ultimately, less acrylamide in processed products. The MSB699 population was SNP-genotyped and SNP frequency was adequate for mapping studies. Objective 4. A student was trained in methods of experimental economics and econometrics needed to conduct research that uses consumer auctions to assess consumer willingness to pay for products. Protocols for 2014 were developed including a cost estimate to draw a random sample of 300 adults to participate in experimental laboratory auctions in central IA, CA, and an East Coast location. Objective 5. Four lines of potato (AF4296-3, ND8229-3, AC96052-1RU, A02507-2LB) with high potential for commercial success as determined by NFPT participants were entered into mini-tuber production, with a goal for producing 10,000 mini-tubers for planting on commercial seed farms in 2014. Trials were conducted to explore whether reduced rates of N (WA and ME) and K (ME) fertilizer could decrease the acrylamide amounts in fried potatoes while maintaining quality attributes needed for processing. The WA trial evaluated Sage Russet and Alpine Russet, which develop levels of acrylamide in products that are representative of recent varieties. In ME, experiments were done with two new, low-acrylamide clones, Easton and AF3362-1. In-season sampling in the N experiments produced data on tuber maturation. Tuber agronomic and fry processing data as well as biochemical indicators of tuber quality and acrylamide-forming potential were collected at harvest and out of storage. Results are contributing to an understanding of how nutrition affects amounts of acrylamide precursors at harvest and during storage. For example, the ME data showed that K rate did not affect acrylamide formation or fry color, but that acrylamide in fries increased by a small amount with increasing N. SCRI Agronomic Trials were conducted with 10 lines in WA, OR, ID, MN, and WI and with 7 lines in ME. Clones were quantified for tuber yield, size profile, specific gravity, defects, and tuber quality. Staff at the USDA Facility in East Grand Forks prepared French fries from each clone that were used for quality evaluations and subsequent acrylamide and consumer attribute testing. Tubers were assayed for sugar and fry analysis, as well as weight loss over time, at the Kimberly Potato Storage Research Facility. These data were provided to industry and contributed to assessments of a line's ability to succeed in commercial production. Semi-commercial storage trials of chip and fry processing clones were conducted in ME and WI to evaluate performance in storage of lines with high priority to industry.

PUBLICATIONS: 2012/09/01 TO 2013/08/31

1. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bethke, P.C., Y. Wang, R. Novy, D. Parish, and A.J. Bussan. 2013. The national fry processing trial (NFPT) and SCRI acrylamide project: Comprehensive, coordinated evaluation of fry processing clones with low acrylamide-forming potential. Potato Association of America annual meeting, Quebec City, Quebec, June 19-23, 2013.
2. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Brandt, T. and N. Olsen. 2013. Harvest and storage acrylamide concentrations of six widely grown potato cultivars. Potato Expo. Las Vegas, NV, January 9-11, 2013. (poster)
3. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation:

Bussan, A.J. and P.C. Bethke. 2013. SCRI advisory committee meeting. National Potato Council Potato Expo, Las Vegas, NV. January 5, 2013.
4. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Adedipe, O. 2013. Near infrared spectroscopy (NIRS) methods development for quantification of acrylamide and its precursors in raw and fried potatoes (Solanum Tuberosum). Seminar presented at the USDA-ARS Unit, Department of Food, and Bioprocessing & Nutrition Sciences, North Carolina State University, February 1, 2013.
5. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Adedipe, O., C. Yencho, S. Johanningsmeier, and D. Troung. 2013. Near infrared spectroscopy (NIRS) method for screening acrylamide content in processed potatoes (Solanum tuberosum). US Potato Board National Chip Program meeting, Chicago, IL, Dec. 10-11, 2013. (poster).
6. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bethke, P.C. 2013. The national fry processing trial and SCRI acrylamide project. Raw product managers meeting, JR Simplot, Caldwell, ID, August 13, 2013.
7. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bussan, A.J. and P.C. Bethke. 2013. NFPT and SCRI project update. NFPT Field Day, East Grand Forks, MN, October 8-9, 2013.
8. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bussan, A.J., D. Parish, Y. Wang, and P.C. Bethke. 2013. SCRI acrylamide project update. NFPT variety selection meeting. JR Simplot, Caldwell, ID. December 17, 2013.
9. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Douches, D. 2013. Mapping in tetraploid populations: QTL analysis of economic traits, double reduction and insights from genome-wide SNPs. The 10th Solanaceae Conference, Beijing, China, Occtober 13-17, 2013.
10. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Gause, K. and G.A. Porter. 2013. Potato processing trials and national acrylamide project. Maine Potato Board Summer Legislative Tour, Aroostook Research Farm, Presque Isle, ME. July 12, 2013.
11. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Gause, K, G.A. Porter, L.B. Perkins, and M.E. Camire. 2013. Nitrogen and potassium effects on potato yield, quality, and acrylamide-forming potential. Presentation at the 97th Annual Meeting of the Potato Association of America, Quebec, QC, Canada. July 28 to August 1, 2013.
12. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Novy, R. 2013. Update on the national fry processing trial and SCRI acrylamide reduction project. 45th Annual Idaho Potato Conference. Pocatello, ID, January 23, 2013.
13. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Olsen, N., L. Woodell, T. Brandt, and M.J. Frazier. 2013. University of Idaho potato storage research and extension program. Kimberly Potato Storage Advisory Committee Meeting, Kimberly, ID, November 19, 2013.
14. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Perkins, L.B., G.A. Porter, and M.E. Camire. 2013. Research on national acrylamide project. Presentation at US Potato Board, Potato Expo, Las Vegas, NV. January 5, 2013.
15. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Porter, G.A. and P.C. Ocaya. 2013. National fry processing trial and USPB/SFA chipping potato trial. Presentation at the University of Maine Cooperative Extension Potato Conference, Caribou, ME. January 24, 2013.
16. Type: Journal Articles Status: Published Year Published: 2013 Citation: Bethke, P.C. 2013. Reducing the acrylamide content of processed potato products through germplasm improvement: Opportunities, challenges and progress. Aspects of Applied Biology 116: 79-87.
17. Type: Journal Articles Status: Published Year Published: 2013 Citation: Bethke, P.C. and

A.J. Bussan. 2013. Acrylamide in processed potato products. American Journal of Potato Research 90: 403-424.
18. Type: Journal Articles Status: Published Year Published: 2013 Citation: Hirsch, C.N., C.D. Hirsch, K. Felcher, J. Coombs, D. Zarka, A. van Deynze, W. De Jong, R.E. Veilleux, S. Jansky, P. Bethke, D.S. Douches, and C.R. Buell. 2013. Retrospective view of North American potato (Solanum tuberosum L.) breeding in the 20th and 21st centuries. G3 3: 1003-1013.
19. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Bethke, P.C. and A.J. Bussan. 2013. Why are we still growing Russet Burbank? Part I. The many weaknesses and great strengths of America?s No. 1 potato. The Badger Common?Tater. 65: 30-31.
20. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Bethke, P.C. and A.J. Bussan. 2013. Why are we still growing Russet Burbank? Part II. Being better than Russet Burbank is the easy part. The Badger Common Tater. 65: 20-21.
21. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Wang, Y., P.C. Bethke, and A.J. Bussan. 2013. SCRI Acrylamide Project Update. Proceedings of Wisconsin?s Annual Potato Meeting 26: 35-36.
22. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Bethke, P.C. 2012. Reducing the acrylamide content of processed potato products through germplasm improvement: opportunities, challenges and progress. Acrylamide, furans and other food-borne contaminants, from plant science to food chemistry. Association of Applied Biologists, Freising, Germany, October 8-9, 2012.
23. Type: Conference Papers and Presentations Status: Other Year Published: 2013 Citation: Adedipe, O. 2013. Quantification of acrylamide in raw and fried potatoes (Solanum Tuberosum) using near infrared spectroscopy (NIRS). USDA-ARS Unit, Department of Food, and Bioprocessing & Nutrition Sciences, North Carolina State University, August 16, 2013.

PROGRESS: 2011/09/01 TO 2012/08/31
OUTPUTS: Objective 1 1a. Conduct multi-location trials. The National Fry Processor Trial (NFPT) evaluated 75 advanced fry processing clones in in ID, WA and ND. NFPT was expanded in 2012-2013 by adding trial sites in WI and ME. The National Chip Processing Trial (NCPT) evaluated 200 early clones at 10 locations in 2011-12. Additional sites in OR and TX were added for the 2012-13. 1b. Evaluate consumer attributes. Fry color evaluations for all lines in the 2011-12 NFPT were conducted at the USDA East Grand Forks worksite (EGF). Sugar and asparagine content of tubers and acrylamide content in finished fries was quantified. Advanced chip clones were processed at Barrel O'Fun Snacks, Better Made Snack Food, Inventure Foods, Kettle, Shearers Foods, and Utz Quality Foods. 1c. Rapid measurement of tuber reducing sugars and asparagine. A GC-MS technique is being developed that has the potential for greater reproducibility and speed of analysis compared to existing techniques. Objective 2 2a. Create lines with a range of tuber reducing sugars and asn. Double silencing lines, with reductions in vacuolar acid invertase and asparagine synthetase, have been generated in Atlantic and Russet Burbank. 2b. Phenotypically and physiologically characterize gene silencing lines. Lines of Atlantic and MegaChip with silencing the vacuolar acid invertase were evaluated in replicated plots. 2c. Establish quantitative relationships between tuber composition and acrylamide in end products. Progress on this objective was not anticipated for this reporting period. Objective 3 3a. SNP for high value traits. Tuber samples from the russet mapping population were sent to Michigan State for asparagine analysis. 3b. Identify marker-trait associations. The chip-processing mapping population (Tundra x Kalkaska) was evaluated for sugar and asparagine. 3c. Range of tuber asparagine in potato germplasm. Potatoes from the Sol CAP diversity panel was used to determine the range of tuber asparagine content. Objective 4 4a. Value and risks for new potato varieties. Data availability from public sources was

assessed, including recent USDA NASS ARMS survey released May 2011 for fall potatoes in ID, WA, WI, ND, MN, MI, ME. 4b. Value and risk with introducing new varieties. A research associate has been hired. 4c. Consumer perceptions regarding acrylamide content and GM. No activities until 2012. Objective 5 5a. Agronomic trials for commercialization of new varieties. Plans for conducting standardized agronomic trials in 2013 at WI, WA, MN and ME are being developed. 5b. Production profiles and maturity indices new lines. Trials are underway in ME, MN, WI, and WA to assess how physiological maturity of tubers affects processing quality and acrylamide-forming potential of potatoes. Physiological maturity is being varied in these trials by supplying nitrogen (N) and potassium (K) at different rates. 5c. Storage profiles of new varieties. No activities until 2012. On-farm commercial production trials will start next year. PARTICIPANTS: Output and impacts represent activities of over 20 p.d.s across 10 research institutions. Multiple processing companies have also participated in activities. More specific information on individual participation will be delineated in future reports. TARGET AUDIENCES: Target audiences are diverse members of the potato industry. This includes potato producers from Maine to Washington. Also includes processors of frozen potato products, chip processors, and end users such as quick serve restaurants and others. Report was published from NFPT trials outlining consumer attribute testing this is available upon request. Currently working to assemble data base that will provide access to all field production and storage evaluations across all of the NFPT and NCPT trials. Producing clean free seed to facilitate field and storage research trials across regions and produce seed for commercial trials on grower fields. Conducted commercial scale trials on new chip clones through collaboration with USPB and chip processors in NCPT. Report on chip culinary attributes and acrylamide levels has been prepared and is available upon request. We have created sub-committees within the advisory committee to assist in directing current activities and communicate outcomes. Full outreach program will be initiated in fall 2012. PROJECT MODIFICATIONS: Phil Hamm is now lead co-P.D. from Oregon State University. Goktepe resigned from OSU and Hamm responsibilities include: national chip processor trial, Tier 1 (1a) national chip processor trial, Tier 2 (1a) national chip processor trial, Tier 3 (5a) Gupta has resigned from University of Idaho. Mike Thornton is now coordinating project activities at University of Idaho. Changes in research activities include: Elimination of phenotypical and physiological characterization of silenced lines (2b) Novy is now completing: identify SNP markers for high value traits in russet potatoes (3a) combine phenotype data with SolCAP genotype information to develop markers (3b) Thornton and Olsen are completing: national chip processor trial, Tier 3 (5a) Budget funding activities linked to 2b are now being used to supplement research activities at Oregon State University and to cover service contract. Oregon State did not receive USPB funds which needed to be replaced by the USDA SCRI funds. Service contract ensures that USPB NFPT and NCPT projects are fully aligned with USDA SCRI funded activities.

IMPACT: 2011/09/01 TO 2012/08/31
Objective 1 1a. Four clones have been identified from NFPT. Three chip clones have been identified through NCPT (LaMoka, Nicollet, MSJ262-A). 1b. Four clones stood out in consumer attribute testing for processing. Taste differences between established varieties and new clones cannot be detected across trials. Objective 2. 2a. Lines have a range of reducing sugars and asparagine contents and have high utility for creating predictive models of acrylamide content. 2b. Eight low-invertase lines of Russet Burbank are being evaluated in replicated plots in 2012-2013 for tuber quality characteristics. Objective 3 3c. Mean asparagine content was 14 mg g-1 DW, and a larger than expected range of values was observed. Minimum tuber asparagine observed was 2.7 mg g-1 DW and maximum was 28.8 mg g-1 DW. It should be possible to breed for tubers with low amounts of free asparagine. Objective 4 4a. Methods of analysis are being developing for using data from standard variety trials to predict the size distribution of tubers and how management can affect tuber

size distribution. Objective 5 5b. These studies are providing baseline data and protocol on the effects of N fertilization on tuber asparagine content in potato varieties. 5c. AO2507-2LB is showing great promise in replicated storage trials at Kimberly ID. Lamoka and Nicollet have shown promise for long-term chip potato storage. Meetings with project Advisory Committee, Project Directors, and variety trial coordinators A planning meeting of PD at the annual meeting of the Potato Association of America in Wilmington, NC on Aug. 16, 2011. A meeting with the coordinators of the NCPT and NFPT in Madison, WI on Sept. 11, 2011. Discussed SCRI project goals and results from NCPT and NFPT with potato breeding community at NCCC84 meeting in Chicago IL, Dec. 12-13, 2011. Discussed project goals, communication plan and subcommittee structure with Advisory Committee at NPC Potato Expo, Jan 4, 2012. Meeting with PD at annual meeting of Potato Association of America in Denver, CO scheduled for August 13, 2012. Conference calls SCRI Advisory Committee conference call. Agreed to coordinate with NPC leadership to prepare a press release. Gave update on research activities. Discussed how best to communicate with stakeholders. Solicited input on how to develop a subcommittee structure with in the Advisory Committee. Sept. 30, 2011. SCRI Executive Committee conference call to discuss administrative structure and sub-committee membership. May 3, 2012. SCRI NFPT subcommittee conference call discussed QSR results, May 22, 2012. SCRI Advisory Committee and PD conference call to discuss progress, sub-committee structure and membership, and research progress. SCRI PD conference call to discuss budget modifications, timeline and requirements for preparing continuation grant. June 13, 2012. SCRI NFPT subcommittee conference call discussed status of NFPT test plots, continuation grant for SCRI, need for equipment at East Grand Forks, and procedure that will be used to selecting lines for QSR process and sensory evaluation, June 14, 2012. SCRI PDs discussed standardization of production and storage protocols, June, 21, 2012.

PUBLICATIONS: 2011/09/01 TO 2012/08/31

1. Halvorsen, Bethke, and Bussan. 2012. An overview of the research project was presented to industry members in two platform talks at the National Potato Council Potato Expo in Orlando FL.
2. Halvorsen, Bethke, and Bussan. 2012. Project goals and approaches were described in a poster presentation at NPC Potato Expo in Orlando FL.
3. Bethke. 2012. A description of the project with an emphasis on production of virus-free seed was presented in a talk at the Wisconsin Potato Seed Improvement Association annual meeting in Antigo WI.
4. Bethke. 2012. Project goals and approaches were described in a poster presentation at Wisconsin Annual Potato Meeting in Stevens Point Wisconsin.
5. Knowles and Pavek. 2012. Research on fry processing trials and physiological maturity were highlighted to industry stakeholders during the 2012 potato field day on June 28 at the Othello Research Unit, Othello, WA.
6. Bethke, P. 2012. Acrylamide in processed potato products. Am J. Potato Res. in preparation.
7. Project PD. 2012. Presentations at commodity group meetings
8. Bulletins, newsletters and other publications SCRI Acrylamide News, Issue 1, distributed to Advisory Committee, PDs, and other interested stakeholders in April 2012.