

**Progress Report to the Maine Potato Board Research Subcommittee
January 25, 2016**

Project Title:

Breeding New Varieties to Provide Marketing Opportunities and Improved Pest Resistance (2015 Growing Season)

Investigators:

Gregory A. Porter, Paul Ocaya, and Tammy Mills; School of Food & Agriculture, University of Maine, Orono.

Executive Summary:

The University of Maine Potato Breeding Program uses traditional plant breeding to create, select, and develop new potato varieties for Maine and elsewhere. The objective of this research is to develop and select new potato varieties which will provide marketing opportunities to the Maine Potato Industry and/or solve disease management problems. During 2015, our research effort by market category was as follows: 50% russets and long-whites for processing and/or fresh market; 40% whites/yellows for chipping and/or fresh market; and 10% reds and specialty varieties. The Maine breeding program is the only eastern U.S. program with an emphasis on russets and long-whites with processing and fresh market potential. This report provides a summary of the 2015 activities.

Caribou Russet (AF3362-1) was named and released during 2015. It is a dual-purpose russet with outstanding yields, bruise resistance, relatively low hollow heart incidence, moderate scab resistance, and reasonably good appearance for fresh market. A plant variety protection (PVP) application has been submitted and Caribou Russet has been licensed to the Maine Potato Board. Sebec (AF0338-17) and Easton (AF3001-6) were named and released during 2013/2014. PVP was obtained and both varieties were licensed to the Maine Potato Board. Sebec is primarily an alternative to Atlantic for chipping out of the field in the mid-Atlantic and S.E. states. It combines high yields, good out-of-field chip quality, verticillium resistance, and much less internal heat necrosis and hollow heart than Atlantic. Sebec can also be used for fresh market, though it greens quickly under fluorescent lights and is moderately susceptible to scab. Easton, a long-tuber-type clone with netted to lightly russet skin, has outstanding fry color and yields, good tuber type, relatively little hollow heart, and very good verticillium wilt resistance. It is primarily a fry processing variety, though it has good boiled and baked quality and can sometimes be pretty enough for fresh market. It has been a top performer in the National Fry Processing Trials (NFPT). Easton has potential weaknesses with rot, skinning, and bruise susceptibility that will require special management attention. It requires less N fertilizer than Russet Burbank.

We have many more promising clones in the development pipeline. Examples include: AF4124-7, AF4172-2, AF4296-3, AF4872-2, and AF4953-6 (promising russets for fry processing); AF4157-6 (an early-maturing chipping clone); AF4648-2 (a mid-season chipper and fresh market clone with scab, PVY, and golden nematode resistance); AF5040-8 (a mid-season chipper with high yields and specific gravity, as well as golden nematode resistance); AF4138-8

(a promising fresh market white with excellent boiled quality, blackspot bruise resistance, moderate scab resistance, medium-early maturity, and relatively little hollow heart); AF4985-1 (a pretty red with good market quality and moderate scab resistance); AF4659-12 (a yellow-fleshed “pinto-type”, fingerling/roaster, specialty variety with an interesting red and yellow skin pattern and excellent cooking quality) and AF5245-1 (a medium-early, purple-skinned, white-fleshed clone with scab resistance). We also have several purple- and red-fleshed clones in the development pipeline.

Priorities in the area of disease resistance are: late blight, scab, and PVY. Because of increasing concerns about PVY in the U.S. potato industry, we have dramatically increased our crossing and selection program for PVY resistance since 2011. Although these diseases were our top priorities, our work on disease and pest resistance also included efforts to develop varieties with resistance to: PLRV, verticillium wilt, fusarium dry rot, pink rot, softrot, nematodes, bruising, internal defects, insects, etc. Marker-assisted selection for potato virus Y (PVY) and golden nematode resistance is now an integral part of the breeding program. We are now developing marker-assisted selection procedures for late blight resistance. Advanced clones in our program typically have resistance to several important potato pests. As an example, AF4648-2, a promising dual-purpose chipping and fresh market white, combines excellent scab resistance with golden nematode and PVY resistance. It also has moderate late blight and pink rot resistance. Progress in breeding for late blight resistance has been dramatic. We currently have 40 late blight resistant 3rd-year clones and 38 more 4th-year and older late blight resistant clones moving through the program and more coming behind them. These clones will be moved forward based on field performance and either developed for commercial release or used as breeding material to produce future commercially valuable cultivars with good field resistance to late blight.

Project Objectives:

1. To breed, select, and develop new potato varieties for Maine which provide marketing opportunities and/or improved pest/disease resistance.

Grant Received:

\$35,000

Accomplishments to Date:

The University of Maine Potato Breeding Program uses traditional plant breeding to create, select, and develop new potato varieties for Maine and elsewhere. The objective of this research is to develop and select new potato varieties which will provide marketing opportunities to the Maine Potato Industry and/or solve disease management problems. Funding provided by the ME Potato Board and USDA-ARS has allowed us to incorporate marker-assisted selection for potato virus Y (PVY) resistance and golden nematode. We are now developing marker-assisted selection procedures for late blight resistance. During 2015, our research effort by market category was as follows: 50% russets and long-whites for processing and/or fresh market; 40% whites/yellows for chipping and/or fresh market; and 10% reds and specialty varieties. The Maine breeding program is the only eastern U.S. program with an emphasis on russets and long-

whites with processing and fresh market potential. Priorities in the area of disease resistance were: late blight, scab, and PVY. Because of increasing concerns about PVY in the U.S. potato industry, we have dramatically increased our crossing and selection program for PVY resistance since 2011. Although these diseases were our top priorities, our work on disease and pest resistance also included efforts to develop varieties with resistance to: PLRV, verticillium wilt, fusarium dry rot, pink rot, softrot, nematodes, bruising, internal defects, insects, etc. This report provides a summary of the 2015 activities.

Progress on Russets/Long Whites: Caribou Russet (AF3362-1), a dual-purpose russet, was named and released during 2015 and a Plant Variety Protection (PVP) has been submitted. Caribou Russet has been licensed by the Maine Potato Board. It has outstanding yields, bruise resistance, relatively low hollow heart incidence, moderate scab resistance and reasonably good appearance for fresh market. Baked quality has been good. It may also be a suitable alternative to Shepody for out-of-field and short-term storage fry processing. PVY susceptibility has slowed building of seed stocks for commercial trials and management of PVY in seed stocks is expected to be challenging for this variety. It is susceptible to internal heat necrosis in southern areas. Easton (AF3001-6) was named and released during 2013/2014. PVP has been obtained and Easton has been licensed by the Maine Potato Board. Easton, a long-tuber-type clone with netted to lightly russet skin, has outstanding fry color and yields, good tuber type, relatively little hollow heart, and very good verticillium wilt resistance. It is primarily a fry processing variety, though it has good boiled and baked quality and can be attractive enough for fresh market under some growing conditions. It has been a top performer in the National Fry Processing Trials (NFPT). Easton has potential weaknesses with rot, skinning, and bruise susceptibility that will require special management attention. It requires less N fertilizer than Russet Burbank.

We currently have many other advanced russet/long-white clones in field and processing trials with McCain Foods. The most advanced and promising are AF4296-3, AF4124-7, AF4172-2, AF4872-2, AF4950-2, AF4953-6, AF5164-19, AF5179-4, and AF5091-8. Yield, tuber type, size profile, internal quality, bruise resistance, and fry processing characteristics are key selection criteria. We are actively participating in national U.S. Potato Board and USDA-NIFA SCRI projects designed to improve the quality of processed potato products (NFPT and SCRI). Easton (AF3001-6), AF4296-3, and AF4342-3 have been among the top performers for yields, low acrylamide levels, and fry quality in the NFPT trials. AF3362-1, AF4124-7, AF4872-2, AF4950-2, AF4953-6, AF5179-4, and AF5091-8 have also done well in these national processing trials.

Progress on Whites and Chippers: Sebec (AF0338-17) was named and released during 2013/2014. PVP has been obtained and Sebec was licensed by the Maine Potato Board. Sebec is primarily an alternative to Atlantic for chipping out of the field in the mid-Atlantic and S.E. states. It combines high yields, good out-of-field chip quality, verticillium resistance, and much less internal heat necrosis and hollow heart than Atlantic. Sebec can also be used for fresh market, though it greens quickly under fluorescent lights and is moderately susceptible to scab.

AF4648-2 combines excellent scab resistance, PVY and golden nematode resistance with good tuber appearance, yields, specific gravity, internal quality, bruise resistance, and chip quality. It also has moderate late blight and pink rot resistance. It does not chip well from cool storage. AF4157-6 is a promising chipping clone that combines early maturity and good out-of-

field chipping in the southern states with excellent storage chip color, including low sugars and the ability to chip from cool storage. It has relatively small tuber size, inconsistent yields, and is scab susceptible, but has moderate resistance to pink rot. AF5040-8 has been a top performer in the national chip trials (NCPT) due to its high yields, high specific gravity, and good internal quality. It has consistently out produced Atlantic and Snowden, while provided specific gravity equal to or exceeding Atlantic. It has attractive tubers, golden nematode resistance, and very pale yellow flesh. It is moderately susceptible to common scab. AF4157-6, AF4648-2, and AF5040-8 have been FAST-TRACKED by the US Potato Board due their outstanding promise for chip potato production.

AF4648-2 (described above) is a promising candidate for both chipping and fresh market use. Scab resistance, PVY resistance, and attractive tuber appearance are strengths. AF4138-8 is also a promising fresh market white. It has bright, attractive tubers, low specific gravity, excellent boiled quality, blackspot bruise resistance, moderate scab resistance, medium-early maturity, and relatively little hollow heart. Yields have been greater than Superior and Katahdin in Maine trials and it has done well in most SE and Mid-Atlantic trials. The tuber size profile has been relatively small in some trials. Several more attractive whites with scab resistance, high yields, and good internal quality are advancing through the program and will soon enter expanded trials and seed production.

Progress on Reds and Specialty Types. Growers have expressed a strong interest in new red varieties that have smooth skin, attractive appearance when grown on our soils, and ability to hold their skin color in storage. Reds are a critical component of the seed potato market and new, well-adapted reds will provide opportunities for our seed growers, especially in VA, NC, FL, and other southern states. This is a new component of the program which was established based on grower input. Red seedling tubers brought in from WI, ND, CO, and ID have been screened in ME since 2008 and entered testing in FL, NC, NY, and ME trials since 2010. Several are showing good potential though it has been difficult to find the ideal combination of skin quality, yields, and bruise/skinning resistance. AF4985-1 fits many of these criteria (good appearance, moderate scab resistance and favorable yield, size profile, and internal quality); however, it has had significant growth crack and sunburning problems in several trials. Seed stocks of AF4985-1 and several other promising reds are being expanded for larger-scale testing in 2016 and beyond.

We currently have two promising specialty clones that should be of interest to small-scale growers. AF4659-12, a yellow-fleshed “pinto-type” specialty variety with an interesting red and yellow skin pattern. It produces small, fingerling-type tubers that are excellent roasted, boiled, or fried. AF5245-1 is purple skinned with white flesh and moderate scab resistance. It is very attractive and has good yields, tuber size, and internal quality. It has much better purple skin color than Caribe, Purple Viking, and other standard purples.

Progress of Disease Resistance: Advanced clones in our program typically have resistance to several important potato pests and/or physiological disorders. As examples, AF3362-1 has resistance to scab as well as excellent bruise resistance; Easton and AF4296-3 have good verticillium resistance; AF4296-3 has good fusarium resistance, AF4648-2, a promising chipper, combines excellent scab resistance with GN and PVY resistance as well as moderate late blight and pink rot resistance. Progress in breeding for late blight resistance has

been dramatic. We currently have 40 late blight resistant 3rd-year clones and 38 more 4th-year and older late blight resistant clones moving through the program and more coming behind them. These clones will be moved forward based on field performance and either developed for commercial release or used as breeding material to produce future commercially valuable cultivars with good field resistance to late blight. These cultivars would reduce the vulnerability of the crop to losses from late blight and would potentially allow growers to reduce their fungicide costs. PVY management has been challenging for the industry in recent years. We have greatly increased crossing and selection efforts for PVY resistance, including the use of marker –assisted selection for PVY resistance. AF4648-2 is the most advanced selection in our program that is immune to PVY. Several other clones are showing good field resistance. Sixty-seven of 177 clones in our scab screening trials had moderate to good scab resistance. Twenty of 50 clones screened for golden nematode resistance (by USDA-ARS in NY) had resistance.

Breeding and Selection Approach: Crossing takes place at Aroostook Research Farm using parents from our program, Cornell University, Michigan State, North Dakota State University, University Wisconsin, and the USDA-ARS, as well as named varieties from North and South America as well as Europe. We generate true potato seed from the crosses and use these seeds to produce greenhouse seedling tubers. Excess greenhouse tubers are exchanged with the USDA-ARS Idaho, Colorado, North Dakota, and Wisconsin breeding programs to gain access to russets, reds, and chippers from their programs that will strengthen our program’s ability to provide new varieties for the Maine industry. This type of exchange program improves the efficiency of potato breeding and variety development throughout North America.

Field selection initially takes place in Northern Maine; however, third- through fourth-year material is quickly advanced to multi-site field testing in ME, NY, PA, OH, VA, NC, FL, and beyond to determine the range of adaptation and assure relatively consistent performance over production environments. We are actively participating in coordinated national projects to improve chipping (NCPT) and fry (NFPT) varieties. We work with growers and processors to commercially test the most promising clones and determine which merit commercial release.

Crosses conducted in the Aroostook Research Farm greenhouse and at Orono during spring 2015 resulted in 425 families and ~280,000 true potato seed (TPS). The top priorities represented in the 2015 crosses were improved russet, processing, and chipping clones, especially with late blight, scab, and/or virus resistance. Seedling tubers (49,828) from prior ME crosses and from germplasm exchanges with other breeding programs (WI, CO, USDA-ARS, and ND) were planted in the field and selected for performance under ME growing conditions. We selected 1410 (2.8%) for continued evaluation in 2016. By category the selections were as follows: 606 (43%) round to oblong white-skinned potatoes for fresh and/or chipping markets; 70 (5%) red- or purple-skinned potatoes for fresh market; and 733 (52%) long-tuber-type whites and russets for fresh and/or processing markets. The selection of red- or purple-skinned potatoes (5 to 11% since 2013) is a marked change for the program and reflects grower interest in developing red-skinned varieties with excellent appearance under ME and Eastern conditions.

A total of 255 second-year clones were selected during 2015 (255 out of 1136, 22.5%). Of these selections, 117 (46%) were russets or long whites. There were 111 round-white or yellow-fleshed selections (44%) and 27 (10%) were red-skinned or specialty clones. Many of these clones were derived from parents with late blight, PVY, and/or other key disease resistance

traits. The 255 selected second-year clones will be advanced to 3rd year testing during 2016 in ME, FL and NC.

Twenty-two of 52 (42%) advanced selections (6th year or older clones) were retained for further evaluation in ME and elsewhere during 2016. The advanced clones that have been selected are distributed as follows: 11 russets and long whites (50%), 5 chippers, fresh market, or dual-purpose whites (23%), and 6 reds, purples, yellows and specialty types (27%).

Twenty-seven of 49 (55%) intermediate selections (5th year clones) were retained for further evaluation during 2016. These were distributed as follows: 13 russets and long whites (48%), 9 round-whites (41%), and 3 red-skinned or specialty clones (11%).

Fifty-three of 125 (42%) 4th year clones were retained for further evaluation during 2016. These were distributed as follows: 27 russets and long whites (51%), 20 round-whites (38%), and 6 colored skin or specialty clones (11%).

Seventy-five of 333 (23%) 3rd year clones were retained for further evaluation during 2016. These were distributed as follows: 47 russets and long whites (62%), 21 round-whites and yellows (29%), and 7 colored skinned or specialty clones (9%).

Minitubers, N1, or N2 seed of the following advanced clones are available from the Maine Seed Potato Board or will become available after the 2016 harvest: Sebec (AF0338-17), Easton (AF3001-6), Caribou Russet (AF3362-1), AF4138-8, AF4124-7, AF4157-6, AF4172-2, AF4296-3, AF4648-2, AF4659-12, AF4985-1, and AF5040-8. Sebec, AF4157-6, AF4296-3, AF4648-2, and AF5040-8 are or have been part of the Fast-Track seed production program of the US Potato Board and/or the US Potato Board/SCRI acrylamide project. This program produces minitubers and start-up seed production for processing trials.

Licensing/Royalties/Commercialization. Until recently, most releases have been public releases (the exception was Reeves Kingpin, licensed initially to McCain Foods). Policies of U.S. Breeding Programs have changed dramatically with Plant Variety Protection and most are now protected and require licensing and royalties. Most future releases from the Maine Breeding Program are likely to be via licensing with favorable terms for Maine growers and/or companies. The Maine Potato Board, University, and stakeholders have worked together to develop a release plan for our varieties. We have named and released Sebec (AF0338-17), Easton (AF3001-6), and Caribou Russet (AF3362-1) since 2013/2014. Plant variety protection (PVP) was obtained for Sebec and Easton. A PVP application has been submitted for Caribou Russet. All three varieties were licensed from the University by the Maine Potato Board. More varieties will be released in the coming years if they show commercial potential. Most are expected to involve PVP; however, depending on the market class and/or expected scale of production public releases may also be used.

Example Recent Maine Releases and Promising Selections. Selections that have performed particularly well in the 2015 ME Breeding Program and Maine regional and advanced trials were:

Chipping

Sebec	Tested as AF0338-17. It has yields similar to Atlantic in the S.E. with very little internal heat necrosis or hollow heart, not a storage chipper, but chips very well from the field in the Southeastern U.S.
AF4157-6	Early maturing with moderate to good yields, excellent chip color, good gravity, bruise resistance. It may work well from the field in the South and from storage in the north. Small tuber size and scab susceptibility are weaknesses. Good yields for an early, but has been inconsistent.
AF4648-2	Mid-season maturity with good yields, chip color, gravity, and bruise resistance. This clone is common scab, PVY, and GN resistant. Susceptibility to greening was a problem in 2015 trials.
Other	Promising chipping candidates that will be tested again in 2016: AF5040-8 (high yields, good gravity and chip color, outstanding in 2014 and 2015 national trials).

Fresh market whites

Sebec	Tested as AF0338-17. Widely adapted, medium to medium late, round to oblong tubers, slight net, fair to good appearance, low external defects, moderately susceptible to scab.
AF4138-8	Bright appearance with slightly netted, round to oblong tubers, excellent boiled quality, early to mid-season maturity, moderate scab resistance, and higher yields than Superior. Size profile can be smaller than Superior.
AF4648-2	Smooth skin, bright appearance, round to oblong tubers, possible chipping and fresh market use, mid-season, very good common scab resistance plus PVY and GN resistance. Susceptibility to greening was a problem in 2015 trials.
Other	Promising fresh market whites that will be tested again in 2016: AF4552-5 (early maturity, moderate scab resistance, good yields, netted skin); AF5280-5 (medium early, bright, moderate scab resistance, large tubers); AF5426-3 (mid-season, bright, moderate scab resistance); AF5450-7 (late maturity, bright, good scab resistance).

Russets or Long Whites

Caribou Russet	Tested as AF3362-1. A medium-late maturing, dual-purpose russet with fair to good appearance, long to oblong tubers, low external defects, moderate specific gravity, and good fry color. It has high yields, moderate to large tuber size, and good internal quality (except for internal heat necrosis in southern areas). It has moderate scab resistance and is resistant to golden nematode and bruise.
Easton	Tested as AF3001-6, this clone produces long, netted to lightly russeted tubers that have excellent fry color. It has very high yields, good tuber size, medium to high gravity, and good resistance to verticillium. Susceptibility to tuber late blight and rot have been weaknesses.
AF4296-3	A late maturing, russet with good fry quality, fair tuber appearance, and high yields. Specific gravity is moderate (average of 1.079 in ME trials) and fry color from storage has been good. It has been an outstanding performer in the national fry processing trials (NFPT). It is moderately susceptible to scab, but has moderate verticillium resistance and good bruise resistance.
Other	Promising russet and long-white candidates that will be tested again in 2016: AF4124-7 (russet, processing, large tubers, possible dual purpose); AF4172-2

(russet, processing, smaller tuber size profile, bruise resistant, possible dual purpose); AF4872-2 (russet, good yields and excellent processing quality); AF4953-6 (russet, good yields, possible dual-purpose); and many more coming; AF5071-2 (russet, good yields and fry quality, processing); AF5091-8 (russet, good yields, possible fry processing); AF5164-19 (russet, good yields, possible dual purpose processing); AF5179-4 (russet, good yields, possible fry processing); AF5312-1 (russet, good yields and scab resistant, fresh market); AF5406-10 (russet, good yields and fry color, processing); AF5407-13 (russet, good yields and fry color, possible dual use); AF5464-4 (russet, good yields, fresh market); WAF10073-3Rus (russet, good yields and scab resistance, possible fry processing).

Reds and Specialty

- AF4659-12 A yellow-fleshed “pinto-type” specialty variety with a interesting red and yellow skin pattern. It produces small, fingerling-type tubers that are excellent roasted, boiled, or fried.
- AF4985-1 Bright red skin with a smooth, attractive skin finish, white flesh, good cooking quality, medium to medium-late vine maturity. Yields are often good, but have been inconsistent due to external tuber defects (primarily greening and growth cracks).
- Other Promising red and specialty candidates that will be tested again in 2016: AF4831-2 (red, white flesh, scab resistance); AF5215-2 (yellow flesh, pink eyes, small tubers, scab susceptible); AF5245-1 (purple, white flesh, scab resistant); AF5412-3 (purple flesh, some late blight resistance); AF5414-1 (reddish flesh, scab resistance, some late blight resistance); NDAF102573-2 (red, white flesh).