Common'Tater Interview with:

Dr. John Bamberg

by Tamas Houlihan, Managing Editor

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Title & Organization: Project Leader, US Potato Genebank
Employer: USDA-Agricultural Research Service (ARS)
Location: Sturgeon Bay, WI
Years in Present Position: 17
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Schooling: PhD, Plant Breeding & Genetics, UW-Madison Horticulture Dept.
Activities/Organizations: PAA member, Chairman of Potato Crop Germplasm Committee, Editor in Chief of American Journal of Potato Research
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Hobbies: Gardening, Biking & Cooking

The potato is a remarkable food crop, but one that is susceptible to many pests, diseases, environmental stresses and quality problems. Fortunately, it has a great wealth of wild and cultivated relatives with genes that mitigate these problems, and are relatively easy to hybridize.

The US Potato Genebank (USPG) in Sturgeon Bay, Wisconsin, is a cooperative project between USDA/ARS and all 50 SAES, with special support from the University of Wisconsin. It is the only federal facility designated to support the germplasm needs of the US potato industry and is the most comprehensive and active collection in the world. It coordinates all aspects of importation, classification, preservation and multiplication, documentation and distribution of germplasm.

A native of Illinois, John Bamberg has been the Project Leader for the USPG for the past 17 years. He has a PhD from the UW-Madison Dept. of Horticulture in Plant Breeding and Plant Genetics. He is the Editor in Chief of the American Journal of Potato Research, and serves as Chairman of the Potato Crop Germplasm Committee.

In the following interview, Bamberg describes the role of the US Potato Genebank in genetic improvement.

What are the goals and objectives of the US Potato Genebank (USPG)?

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The overall goal of USPG is genetic improvement of the potato crop in ways that benefit society. Those benefits can take on many forms and be applied to several groups. A definition of a "better" potato includes one that makes more money for producers and processors. It includes nutritional improvements that benefit consumers by improving health and reducing medical costs. A better potato would be more efficient to grow and naturally resistant to pests and stress, thus reducing environmental impact. So, for example, less water would need to be taken *out* of the environment and fewer pesticides put *in*.

No one group performs all aspects of potato improvement. We do not, of course, determine how to best promote, sell, package or process potatoes or grow them commercially. We do not develop optimum management practices of breeders' new selections or breed those new cultivars ourselves. We generally do not even get involved in adapting exotic stocks to the form in which they can be used as breeding parents. Rather, our part is the very foundation level of the whole process. Some centralized group needs to collect (and import), classify (and document),

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preserve, evaluate and distribute the raw genetic materials for these others to use—that is our role.

One area that we have particularly developed is studying the status and dynamics of genetic diversity in the collection. In other words, as we manage these germplasm populations, what factors put genes at risk for being lost? We have often used wild populations native to the USA for such studies, making trips to southwest states to gather material for study as well as for incorporation into the genebank collection.

The collection can be seen as a big toolbox of germplasm that can be used to fix problems of the potato crop. Following this model, it will be most useful if staff make it their goal to 1) have the broadest possible diversity of tools—thus know what we have and what we still need to get; 2) make sure we don't accidentally lose any; 3) keep them clean (i.e., disease free), and organized (well documented); and 4) know all we can about the best techniques for using them.

How is the USPG funded? How is it staffed?

We are a cooperative initiative of several partners. The genebank started about 50 years ago as the first interregional project (IR-1) with all the states' contributing "off-the-top" Hatch funds. CALS/UW Horticulture has provided some direct staff support for many years, and UW also provides major inputs in infrastructure, equipment and utilities at our home site, the Peninsular Ag Research Station. Finally, USDA-ARS has provided major funding and administration, and its role is expected to increase. So, although historically most of the staff have been UW employees with only the Project Leader as a federal USDA scientist, most or all of the staff are expected to become federal in the future.

What are the key improvements the USPG researchers (and others) are targeting through potato breeding?

There are several ways in which breeders are using USPG germplasm to improve the crop. Of course, there is an ongoing struggle with the common, well-known fungal, bacterial and viral diseases and insect pests—i.e., the "biotic" problems. Then there are the common "abiotic" problems like environmental stresses. A big part of that are tuber defects like bruise, hollow heart, and sugar end. We try to interface with various breeders who are working on all of these types of common limitations to getting a good yield of quality product to market. To be helpful, we need to have gathered, documented, preserved and evaluated exotic germplasm to be able to identify which stocks have the most potent genetic solutions to the problem. We also have to have at least some basic knowledge of, and, ideally, experience with the respective problems. Then consider that you might buy the same item for the same price from two different hardware stores, but the one that can give you good advice on how to use their product is giving you much more valuable service. So it is with germplasm. Thus, we make it a goal to know how to grow and cross the stocks, and any other details that will make it easier for breeders to use them.

Another way breeders can make progress with germplasm is by addressing new challenges and taking advantage of new opportunities. Since genebank staff routinely work with the whole broad array of potato genetic diversity, we have a special opportunity to notice and describe novel traits that might have application.

Chemical inputs have multiple negatives. They add to the cost of production, and cost time and energy for application. They pose a real or perceived health risk to the producer, consumer and environment. Stocks from the genebank have the potential to address these problems without the negative side-effects of chemicals. We need to move in the direction of making genetic solutions as fast and flexible as chemicals.

Finally, breeding is a tremendous sifting game, looking for the right combination of many traits among hundreds of thousands of seedlings. Anything that can be done to make the process more efficient will help the industry. Since exotic stocks from the genebank often have extremes of expression for breeding traits, these can be studied to better understand the

Collecting wild potatoes on the top of Miller Peak in the Huachuca range of SE Arizona.

underlying genetics and physiology, and thereby develop more efficient screening methods.

What can you tell us about the progress being made in terms of late blight resistance research?

The genebank is playing an active role in addressing the late blight challenge. We provided many late blight workers in the US and abroad with resistance standards and numerous other stocks that have now been incorporated into breeding programs. Many foreign breeding programs were contacted such that advanced and basic genetic stocks were requested, imported, advertised and distributed to breeders. We also are participating directly, confirming the extreme resistance of stocks already documented, and exploring for and finding high levels of resistance in more user-friendly species with cooperators in Mexico, Canada, Russia and several US states. We assisted genetic analyses by making and providing segregating families for blight resistance. The genebank, in partnership with the Potato Crop Germplasm Committee, also sponsored grants to screen for tuber blight resistance.

Maybe the best example of the usefulness of the genebank with respect to late blight resistance is in the story of the RB gene which provides strong and durable resistance. It has its origin in a very weedy wild Mexican species collected and deposited in the genebank many years ago. It had been faithfully preserved and characterized long before the payoff was foreseen. Technology slowly developed that would make the discovery and use of this gene possible. There are many such success stories for other traits—nearly all commercial varieties have exotic germplasm in their pedigrees. Consider, for example, the great practical value of the "odd" trait of resistance to cold sweetening found in germplasm. There is no reason to doubt that many more such useful traits are waiting to be discovered.

Has there been any research related to breeding for nutritional improvements in potatoes?

John Bamberg (second from right) is shown with a group of late blight researchers at the late blight testing site in Toluca, Mexico.

Nutritional improvement is a very exciting area. Everything else we do is geared toward producing the standard potato in a more efficient way. How great it would be to also develop a potato product that could truly wear a bold "new and improved" label on the package. After all, unless people start eating significantly more food overall, the question is whether they will continue to choose potato over other options.

We should explore all reasons for them to do so. We are in an extremely powerful position as a crop. The amount and frequency eaten gives even small improvements in potato the potential for great impact on the health of the population. For example, most of us get only half the daily recommended potassium, but perhaps 1/3 of that is contributed by potato in the diet. We are beginning to work on the potassium potential of germplasm in the genebank. Similarly, we are characterizing potent anti-cancer compounds almost unique to potato with colleagues at the medical school in Madison. In cooperation with partners at Texas A&M, we have identified white-fleshed species very high in antioxidants. As consumers become more health conscious, they are going to recognize and put value on these nutrients, and be motivated to choose potato if it has them.

How does the USPG aim to link research results with farmers in the fields?

While working at the genebank is exciting, it would be a whole lot less appealing without a paycheck. In the same way, we try to keep in mind that the public wants its "paycheck" too. That is, the public investment in the genebank comes with the expectation that tangible benefits will be returned. Are we delivering? Yes. While little of what we do has direct application to farmers, we are confident that our activities eventually put money in their pockets and those of others in the industry. No other crop approaches the existence, collection, research, and use of related wild species seen in potato. It has been estimated that about 50% of the four-fold advance in potato yields in the 20th century has been due to genetic improvement, and about 1% of annual value of all crops may be credited to exotic germplasm. That puts the contribution of exotic germplasm at around $10-25 million per year for potatoes in the USA. Considering that the size of the collection is increasing, as are advances in technology to put it to use, we are not embarrassed to ask the public and industry to continue, and even increase the funding needed for a strong genebank program.◆