

National Roadmap for Red Raspberry Research, Teaching and Outreach Activities

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I. Background

This work builds on efforts started by the USDA's Regional Integrated Pest Management Centers. They funded crop profiles-- documents that tell what activity and crop protection tool is needed to produce commercial red raspberries in the U.S. (http://www.ipmcenters.org/cropprofiles/CP_form.cfm).

From crop profiles, the next step was creation of Pest Management Strategic Plans (PMSP). These documents prioritized pest problems based on how hard pests are to control and what environmental issues arise from pesticides used to control them (http://www.ipmcenters.org/pmsp/pmsp_form.cfm?usdaregion=National%20Site). PMSPs list critical needs, including research, regulatory and extension activities. PMSPs are valuable because they help focus efforts and provide an agreed-on "to do" list. In the U.S., there are seven crop profiles and two PMSPs that apply to raspberries.

Just as addressing pest management needs in an organized way will move the U.S. industry forward, so will adding in the other important production factors. The final task is to draw a broad industry roadmap with these additional research and extension goals. The purpose of the roadmap is to guide all parties to the same goal—increase industry viability-- whether work parties are approaching it from different disciplines or using different timelines and funding sources.

II. Preliminary Efforts

In 2011, a group of scientists and industry stakeholders submitted a raspberry proposal to the USDA-SCRI program. The purpose of this program is to fund complex research and extension projects. It can also fund proposals that promise to bring stakeholders together to plan and submit a complex grant proposal the next year. This proposal type is called a planning grant. In 2011, USDA-SCRI funded a planning grant titled *Roadmap Development for U.S. Raspberry Producers: Forging Links between New Tools for Breeding Programs and Crop Markets*. Besides promising to submit a complex grant proposal on raspberries, the planning grant also promised to create a national roadmap.

The planning grant paid for open participation workshops in 2012 in Sandusky, OH, and Seattle, WA. The purpose of the workshops was to solicit input from all stakeholders about issues relating to growing and marketing red raspberries in the U.S. Participants included:

- Growers (Rock Springs Farm, SandHill Berries, Honcoop Farms, Sakuma Bros., Minaker Berry Farm, Enfield Farms)
- Marketers (NaturRipe, Sakuma Bros, SandHill Berries)
- Processors (SandHill Berries, Sakuma Bros., Enfield Farms)
- Industry Organizations (IRO, NARBA, WRRC)

- Plant Propagators (Indiana Berry and Plant, North American Plants, Nourse Farms, Norcal)
- Private Breeders (Driscoll's, Garden's Alive, NaturRipe)
- Publically-funded Breeders (NY, NCSU, WSU, USDA-ARS)
- Other Grant Holders (RosBREED, Black Raspberry Planning Grant)

Information from these workshops was combined with nine other sources (see References section) to build this roadmap. A working group of scientists and industry advisors has formed to submit a research and extension proposal to USDA-SCRI.

III. Roadmap Development

The U.S. red raspberry industry is made up of a number of independent grower/marketer organizations. Each uses its resources to improve member's bottom line. They may or may not participate in the International Raspberry Organization (IRO) efforts to grow raspberry production worldwide. Even though their focus, specific needs and ability to fund research vary, all of these red raspberry organizations have common **long-term¹ goals:**

- Improved horticultural traits
- Improved pest resistance/tolerance traits
- Season extension (i.e., cold/heat tolerant)
- Better definition of fruit characteristics that appeal to consumers
- Improved profitability
- More publicly funded plant breeders (to deliver more cultivar choices)

These long-term goals can be loosely grouped under three umbrellas: plant breeding, consumer studies and economics. Together, these three areas drive industry viability and form the core areas of the national road map.

A. Core Areas

1. Plant Breeding

Germplasm screening, to either look for new traits or "stack" known traits, is the backbone of the industry. Screening is done by both private entities and public agencies based in the region where the plants will be grown. Resources (i.e., time, money,

¹ As stated by industry stakeholders in documents, workshops and other media (see References).

personnel, and land) for screening are limited, especially among the four publicly funded breeding programs. As a result, the rate at which new traits are discovered and new varieties are released is slow. This is a major stumbling block to strong growth of the red raspberry industry, both in overall size and in expanding to new growing areas.

2. Consumer Studies

In this road map, the term “consumers” includes the general public, processors (those who formulate raspberry products to put in foodstuffs) and manufacturers (those who produce foodstuffs for the retailer). Scientists know little about the fruit characteristics that draw consumers to buy raspberries. Which characteristics, or combinations, are the most popular in which parts of the U.S.? Which ones cause a consumer to reject raspberries for other fruits? Without this information, growers and marketers can’t clearly tell plant breeders what fruit characteristics they want in a new raspberry cultivar. This is the second major stumbling block to strong growth of the red raspberry industry.

3. Economics

One of the decisions growers must make in order to succeed in business is which raspberry cultivars to plant or replant. Enterprise budgets are important tools in helping a grower measure business costs before committing. However, no data exists on the price consumers would be willing to pay for raspberry fruit with characteristics they most like. Without that data, moving to a new cultivar that could capture niche market opportunities becomes an economic risk for growers. This is the third major stumbling block to growth in the red raspberry industry.

B. Articulation

As previously mentioned, plant breeding, consumer studies and economics form the core areas of the national roadmap. Each area is important on its own. However, work in all three areas needs to be functionally exchangeable with each another. For example, imagine that food scientists identify a chemical in fresh or processed fruit that consumers love. It is not enough that results are published and shared with industry. The genetic material that produces this chemical must be identified (and a reasonably priced testing kit developed) so that plant breeders can find it and use it in their crosses. Rather than producing a new raspberry cultivar and then developing enterprise budgets, a more grower-centered approach is to first discover what consumers are willing to pay for a raspberry fruit with a specific taste, color, health benefit, etc. Providing this kind of data to plant breeders would enable them to pick cultivars that they know will be economically successful for growers.

C. Measurements

It is hard to measure change if there is not a uniform system that is number-based rather than description-based. Many plant traits are still determined “by eyeball” or “by experience”. Researchers with a great deal of experience can turn out fairly uniform and consistent data, just by using their eyes, taste buds and noses. Because of this, there is a long-held opinion that it saves time and resources not to have to measure all traits. The belief is that “if there is only one public breeder at a time in each location, there is little data variability”.

This approach relies on a high training level and many years of experience in just a few people who can still be in only one place at one time. Number-based measuring systems would allow student interns to collect more data from more test plants than could one plant breeder. It would also standardize data for comparison across people, locations and years.

“Experience” measurements also make it hard to compare data across disciplines. For example, a food scientist looking at consumer’s preference for the balance of sweet and tart taste, would measure pH ranges and brix levels. As a second example, if consumers were asked to rate seed crunchiness on a “like it” or “hate it” range (and match it to an economic decision) food scientists would measure the crunchiness and report it as a number.

In short, any trait that gives an economic advantage (or disadvantage) should be quantified. That way information can be easily translated into a practical action in another discipline.

IV. Future Directions

1. Increase the Number of Tools

Field testing of plants is the single reason it takes 7 – 10 years (or longer) to release a new cultivar. Thoroughly testing plants for their ability to do it all--grow well, fend off pests, and produce good fruit at a fair price-- takes that long. The rarer the trait the breeder is searching for, the more plants have to be tested to find it.

To accelerate field testing, new tools and work methods must be developed to rapidly measure many traits in hundreds of individual plants, predict or identify mature characteristics at the seedling stage, and develop growth chamber or tissue culture methods that identify promising seedlings early on. The earlier those tests results come in, the fewer resources are put into plants that do not have the traits needed.

Developing more molecular tools—specifically, gene markers—is key to quickly and effectively screening parent lines and their offspring for many desired traits. Having molecular markers for important traits means that lab screening could be done on seedlings. Re-screening of field plants could also be done to lower the chance of mistakes.

Genetic markers from other *Rosaceae* crops should be tested in red raspberry to piggyback on existing work. Genetic maps must be created for red raspberry in order to identify gene markers. Lastly, affordable and portable testing kits need to be created with these markers for use in the field or greenhouse. Culling decisions can be made faster when samples don't have to be collected, sent to a lab, and results reviewed weeks later.

2. Increase Collaborations

Successfully addressing these three focus areas requires more than just plant breeders, food scientists and economists. It will also require entomologists, nematologists, plant pathologists, horticulturists, irrigation specialists and a host of others to fine-tune production systems. It will take many coordinated research steps, conducted over a number of years by different personnel and in different environmental locations.

For real progress to take place, everyone interested in the future of the U.S. red raspberry industry (e.g., public and private breeders, propagators, private nurseries, scientists, growers, industry organizations and others) must work together. It will take more than just increasing the number of new raspberry cultivars to make gains against other fruit systems. To keep making gains, and hold on to markets, industry needs to supervise a feedback loop in the roadmap. Data must be collected in a way that it can be used immediately in another discipline without translation. No matter which core area collected the data, it must be articulated with the others to improve plant selection, guide fruit marketing decisions and provide more grower options. Growing conditions will change, new market opportunities will arise and new consumer preferences will be identified. A supervised feedback loop will ensure that the three core areas continue working in concert.

3. Focus on Training Future Scientists

Training future scientists is critical in all focus areas. They will feed both public and private sectors. At the social level, forming partnerships with middle school and high school biology programs could encourage young people to choose science as a career. At the practical level, even something as small as encouraging the use of the raspberry as a subject plant in basic biology would help. Publishing number-based data on important horticultural traits is useful.

Financial support of both undergraduate and graduate students is also needed. Research and outreach activities should both be emphasized. Students need to have more interaction with stakeholders to enable long-term collaborations. At the same time, universities should involve growers, processors and industry leaders more in developing grant proposals and reviewing research and outreach activities. Exposure strengthens industry's ability to understand and successfully navigate the complex social and environmental issues which granting agencies require for funding proposals.

V. Future Leadership and Coordination

This roadmap was developed based on conditions from 2010 - 2014. New scientific discoveries are expected. Data from other fruit crops will become available. Funding situations will change. World economic forces are changing. In order for this document to have relevance in the future, a Roadmap Working Group must be formed.

The initial charge of this working group would be to update the document at regular intervals, add new areas as necessary, and supervise the feedback loop. In other words, to maintain the focus on functionally exchangeable information. Local and regional efforts are very important and should continue. However, more progress will be made in addressing common problems and building common tools if the roadmap is industry promoted and industry maintained.

VI. References

Aggregated Long Term Goals	Source
Improve germplasm (i.e., horticultural traits)	NBCI (2010), NARBA (2013), NCSFR (2014), WRRRC (2014), USDA-ARS NP 301 (2011), Daniels et al (Jan 2012), IRO meeting (2012)
Improve pest resistance/tolerance	Peerbolt (2008), NARBA (2013), NCSFR (2014), WRRRC (2014); Daniels et al (Jan 2012), IRO meeting (2012), Hazelrigg (2009)
Improve profitability (i.e., yield, markets)	NBCI (2010), NARBA (2013), Daniels et al (Jan 2012), USRRC (2013)
Increase cold tolerance/heat tolerance (i.e., season extension)	WRRRC (2013), Daniels et al (Jan 2012), Daniels et al (May 2012), USDA-ARS NP

	301 (2011)
More publicly funded plant breeders	Peerbolt (2008), USDA-ARS NP 301 (2011)
Fruit characteristics (e.g., provide data on taste, color, health benefits, etc.)	Daniels et al (Jan 2012), Daniels et al (May 2012), IRO meeting (2012)

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