



THE ORTET

Volume Four

Midwest Apple Improvement Association
Autumn 2018 Newsletter



In This Issue

Business

- 3 A Message from the Chairman
- 4 President's Report
- 6 Grafting over to MAIA Varieties
- 6 Update from Wafler's Nursery
- 7 Results from the MAIA1 Survey

Research

- 8 A Word from our Science Committee
- 9 The MAIA Research Pipeline
- 10 Ohio Cider: Year 2
- 12 Host Resistance of MAIA Apples to Fungi that Cause Summer Fruit Rots
- 13 Genomics and Metabolomics
- 14 Stepping Up the Mission: Disease-Resistance, Frost-Tolerance, and More

MAIA Board of Directors

Gregg Bachman

Sunny Hill Fruit Farm, Carroll, OH

Felix Cooper

Garden's Alive!, Tipp City, OH

David Doud

Countyline Orchard, Wabash, IN

Jim Eckert

Eckert Orchards, Belleville, IL

Allen Grobe

Grobe Fruit Farm, Elyria, OH

David Hull

White House Fruit Farm, Canfield, OH

Andy Lynd

Lynd Fruit Farm, Pataskala, OH

Dano Simmons

Peace Valley Orchard, Rogers, OH

MAIA President

Bill Dodd

Hillcrest Orchard, Amherst, OH

MAIA Advisors

Mitch Lynd

Lynd Fruit Farm, Pataskala, OH

Dr. Diane Miller

The Ohio State University

Newsletter Staff, Ciderwood Press

Amy Miller, Editor-in-Chief

Kathryn Everson, Layout Editor

Key to MAIA Releases: Cultivar, Trademark, and Test Names

Trademark Name	Cultivar Name	Test Name	Parents/Cross	Patent Number
EverCrisp	MAIA1	MDD5-44	Honeycrisp x Fuji	PP24,579
Rosalee	MAIA11	MDD5-41	Honeycrisp x Fuji	PP29,146
Summerset	MAIA12	MDD3-75	Honeycrisp x Fuji	PP29,213
Ludacrisp	MAIA-L	Juicy Fruit	Honeycrisp, open pollinated	Patent Pending
Sweet Zinger	MAIA-Z	MJE 1238	Goldrush x Sweet 16	Patent Pending

A Message from the Chairman



David Doud
MAIA Chairman of the Board
Countyline Orchard, Wabash, IN
Photo credit: Ann Hunt

On January 1, 2019 MAIA takes the next step in its evolution when Bill Dodd takes the helm as full time President.

Founded in 1998 and organized as an 'Association,' in 2010 it became time to release material. Our founders did not want to deal with the responsibility and paperwork associated with this 'business.' At a board meeting in Mitch Lynd's living room, options were discussed. To make it clear that change was necessary, it was proposed the organization be disbanded. Material would belong to the farm where the seedlings were located to do with as seen fit. There was little support for this idea, but also no clear alternative.

Enter Fruit Growers Marketing Association. This Ohio cooperative markets and supports wholesale apples for members and was well represented in both MAIA membership and on the MAIA board. It was proposed and accepted that FGMA would administrate the Midwest Apple Improvement Association moving forward. FGMA would receive 50% of the income from MAIA in return. At the time MAIA had about 50 members @ \$100/year and some possibly promising varieties.

Enter Bill Dodd. Bill was president of FGMA and was tasked with the responsibility guiding MAIA into the future in addition to his responsibility with FGMA.

Bill oversaw the change from 'Association' to the incorporation of MAIA as a 'Cooperative' under the laws of the state of Ohio. He brought the organization into compliance with the IRS. Patent attorneys were retained as the MAIA board made the decision to move forward with MAIA1 (EverCrisp™ apples). Importantly, Bill conceived the grower friendly 'managed open release' model, which became MAIA's mechanism to make varieties widely available to grower members while creating an income stream to maintain the organization.

Fast-forward 9 years and MAIA has outgrown part time management. Five varieties have been released. Membership has grown ten fold. An international agreement was negotiated associated with MAIA1 variety. International organizations are evaluating other selections. A marketing association has been formed to manage the introduction of EverCrisp™ into the wholesale market. Breeding along with testing and evaluation of new material continues. Responsibilities along with opportunities abound.

Bill Dodd is the right person at the right time. Well known and respected, past president of the US Apple Association, IFTA board member, AFG's Fruit Grower of the Year, Bill's optimism and enthusiasm has well served the fruit growing community's larger interests.

Similarly, MAIA is the right organization at the right time. Quote from a survey returned last year. "Hopefully we can make good money with this model. The other clubs require so much investment for a chance to roll the dice, and the investment is all on the grower. I like this grower friendly model, keep doing it. THANKS!!"

FROM THE PRESIDENT:

MAIA Goals Redefined



Bill Dodd

MAIA President, Hillcrest Orchard, Amherst, OH

To obtain licensing agreements for MAIA varieties and to learn more about MAIA go to:

www.midwestapple.com

Midwest Apple Improvement Assoc.
P.O. Box 88
Oberlin, OH 44074

MAIA Annual Meeting

The MAIA Annual meeting will be Monday February 25th at 5:44 pm at the Holiday Inn in Rochester, NY. The meeting will be held in conjunction with the International Fruit Tree Association meeting.

Did you know?

The one-millionth MAIA1 tree will be planted in 2020!

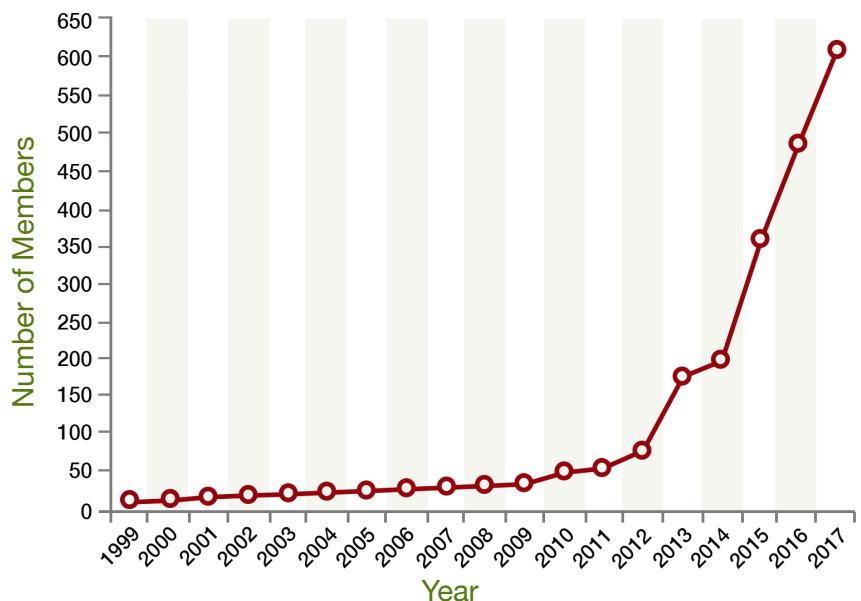
MAIA's goal is to "release new apple varieties that will ultimately increase per capita consumption of apples." This is a statement that I blurted out to a reporter recently, when asked what MAIA's goals were? As an organization, can we dare to dream or say this out loud?

When MAIA was formed 25+ years ago the stated goals were to come up with new apple varieties suitable for the growing conditions in the Midwestern United States. All the members were smaller growers and the goals reflected their somewhat limited view of the apple industry. Most founding members did not send their apples outside of their county, some shipped within their state, but competing on a national scale or a world stage was never considered.

MAIA1 or EverCrisp® has changed everything. A recent EverCrisp® marketing group meeting revealed that the 2018 crop is already sold to customers who tried them in 2017. The common buyer statement is "I want every EverCrisp® that you produce!" Tripling production from 2017 to 2018 is not going to come close to meeting the expected demand! Plantings are ramping up for 2019, 2020, 2021 and beyond but demand will outpace supply for years to come. Many growers have confided to me that the biggest mistake they've made in the past 3 years is not planting more!

The MAIA manifest is growing! Summerset®, Rosalee®, Sweet Zinger® and Ludacrisp® are available to MAIA members to order and plant. It is difficult to say which of these will capture buyers' and consumers' hearts next. They all have tremendous upsides, but they also have challenges and unknowns. My recommendation is to get some test trees and see for yourself. Fruit will be available to sample and view at winter meetings.

MAIA Membership Growth



MAIA began as a grassroots grower movement. The organization is evolving and wants to become more relevant to its members. Many tools are already available to MAIA members, such as:

- Access to the FLM Harvest tool box of marketing materials. FLM Harvest is a public relations firm that has been contracted by MAIA to help launch and develop the EverCrisp® brand.
- An MAIA Member Group Facebook page is available for members to share horticultural challenges, successes and compare notes on MAIA varieties.
- The EverCrisp® Marketing Committee meets to discuss introducing EverCrisp® into new wholesale markets. They are developing quality requirements and packaging and have applied for and received a PLU number for EverCrisp®. They will work toward moving EverCrisp into a higher-priced crop insurance tier.
- Consumer targeted social media and web sites are being developed for the new variety releases.
- Breeding continues and new selections are discovered every year. They will then go through a consumer evaluation process. Crosses of EverCrisp® and Pixie Crunch (disease resistant, early season harvest) are beginning to yield fruit and we are hopeful to come up with an earlier EverCrisp® type apple with the potential for disease resistance.

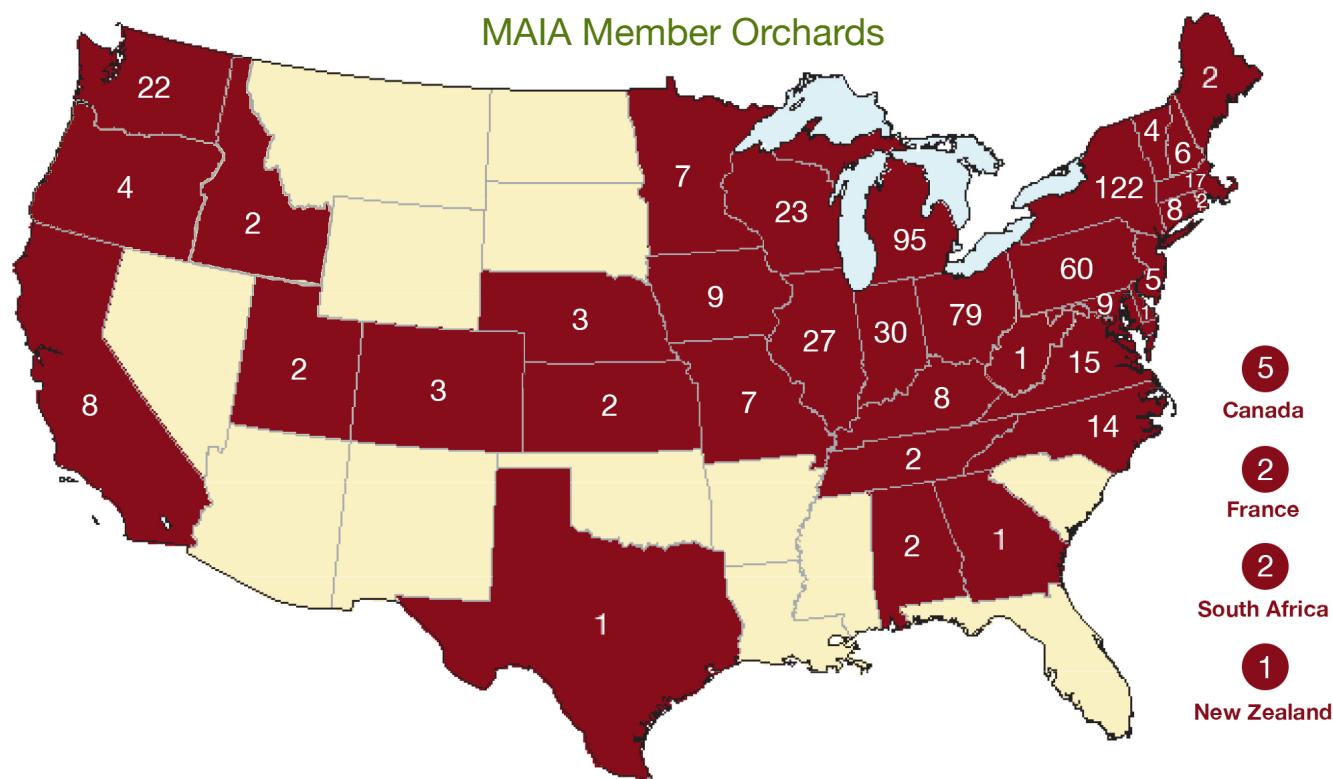
● Selections that score highly in consumer evaluations may make it into the MAIA “Play Book”. The Play Book contains information about our 18 most exciting apples.

● MAIA is actively working on identifying new hard cider varieties. The goal is to find desirable selections that can be grown under today’s commercial planting systems. Fruit size and annual cropping along with flavor attributes are some of the traits we are seeking.

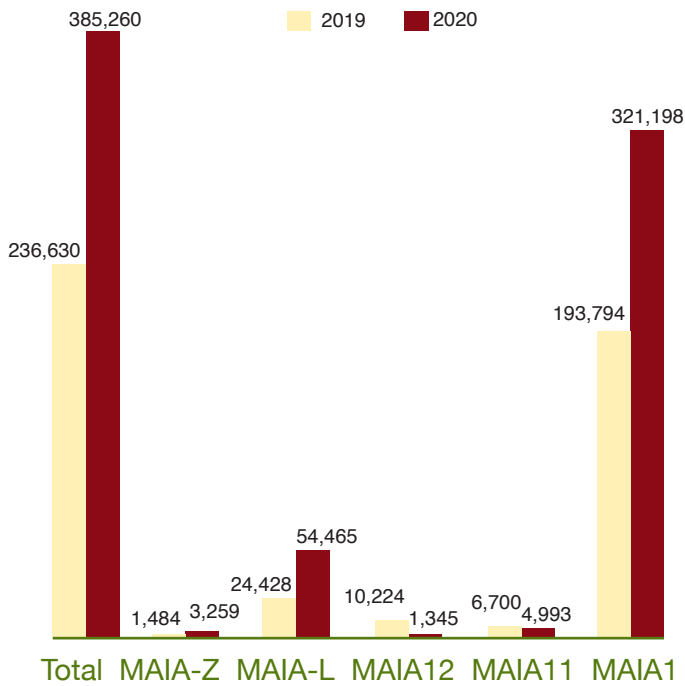
● In 2019 MAIA expects to form a new company in partnership with the International Pome Fruit Association (IPA). The new company will be charged with the International marketing and branding of EverCrisp®. IPA has been working to apply for Plant Breeders Rights (international equivalent of a plant patent) and trademark protection around the world. IPA has partners in Australia, Chile, Italy, New Zealand, South Africa and the US. Outside the US and Canada EverCrisp® will be a managed variety.

Vibrant, forward-thinking organizations survive by constantly reinventing themselves. Reassessing goals and raising the bar of expectations is an important step in the process. MAIA is ready to take the next step! Thank you for your support of MAIA. How incredible will it be to tell our grand children that we were the generation that increased per capita apple consumption 4 lbs. per person!

MAIA Member Orchards



Projected Tree Sales of MAIA Cultivars



Update from Wafler Nursery

We are currently reserving rootstock for 2022, 2023, and 2024. Growers need to call and let us know what rootstock they would like and the amount. This is the only way to guarantee that we will have the rootstock/variety combination that they want. The minimum on an order is 200 trees. They do not have to tell us the variety until the spring before we bud the trees.

MAIA cultivars budded and sold for 2020:

Product	Amount Budded 2020
EverCrisp® cv 'MAIA1'	64,538
Ludacrisp™ cv 'MAIA-L'	50,265
Rosalee™ cv 'MAIA11'	4,253
Summerset™ cv 'MAIA12'	645
Sweet Zinger™ cv 'MAIA-Z'	2,709

Grafting Over to MAIA Varieties

Grafting blocks over to more desirable varieties is now the norm in the apple industry. MAIA is excited to assist growers interested in top working blocks over to MAIA varieties. Top worked trees will be treated like newly planted nursery trees. MAIA membership is required, a \$1.00 per tree royalty is due August 1 of the year that top working takes place. The 20-year trademark contract also needs to be signed and submitted to the MAIA office. MAIA can help you find bud wood.

If you would like to graft existing blocks over to MAIA patented varieties, please submit the following information to Bill Dodd, either by mail or email.

REQUEST TO GRAFT OR TOP WORK TREES

DATE: _____

MAIA MEMBER NAME: _____

NUMBER OF TREES TO GRAFT BY VARIETY:

_____ MAIA1 (EverCrisp)

_____ MAIA11 (Rosalee)

_____ MAIA12 (Summerset)

_____ MAIAL (Ludacrisp)

_____ MAIAZ (Sweet Zinger)

_____ TOTAL

Royalties due August 1 (\$1.00 per tree)

WHERE WILL BUD WOOD BE SOURCED?

NAME: _____

SIGNED: _____

Submit request to: BILL DODD, MAIA

Email: billdodd04@gmail.com

Or mail to:

MAIA, P.O. Box 88, Oberlin, OH 44074

Results from the Survey: MAIA1/EverCrisp® Apples

A survey was distributed last year regarding grower experiences with MAIA1 trees and EverCrisp™ apples. Results were used to help author the 'MAIA1 trees/EverCrisp™ apple grower guidebook' sent to MAIA members last July. The single standout take home point is to do a great job with site preparation and tree care so as to avoid runted plantings. If you make the investment, do it right.

During the harvest of 2018 we learned that EverCrisp™ apples will mature on the Leelanau peninsula in Michigan. It is encouraging to ripen fruit this far north at about the 45th parallel. Reports from NY and MI indicate that fruit on 4th and 5th leaf trees were red and smooth. Concerns about appearance were allayed.

During the third week in October our international partners (IPA) toured MAIA1 plantings across several states. They saw what they had hoped in regards to appearance and cropping. There were locations where it appeared that pollination was inadequate. Productive blocks tended to be in the middle of good pollen sources, while blocks which bordered on fields and roads tended to a light set. It is suggested to place bees strategically to maximize the MAIA1 block to bee activity. Work will be done in the future to research this situation.

An observation that was shared by our IPA partners was the consistency of quality of this apple across many sites. Everywhere sampled the variety offered the same powerfully sweet crispy eating experience.

Beyond that, we solicited and received many comments. Here are some of them and our replies:

Comment: "Provide information pamphlets to hand out at our retail stand about EverCrisp™ apples."

Response: Harvest FLM, our marketing firm, has prepared a single page handout with the MAIA/EverCrisp™ story. Access it at the MAIA website and use it in your marketing.

Comment: "Should have private Facebook group..."

Response: This has been established – Enter "MAIA Member Group" in your Facebook search bar and click 'join'.

Comment: "Create a chart that follows numbering/naming of MAIA selections so as to identify test trees."

Response: Find a chart in this publication.

Comment: "Make trees available faster/Help me get more trees"

Response: MAIA does not propagate or sell trees. Members need to work with a nursery to acquire trees. MAIA will license your tree provider and work with them to get the necessary propagation wood. In recent years rootstock supply has been a problem and nursery capacity has been selling out. Don't procrastinate, establish a relationship with a nursery and order rootstocks/trees. Do not expect trees to be available 'next spring', that's not the way it works anymore.

Comment: "More information on where to sign up for new varieties or test varieties."

Response: If your orchard has a specific need for a variety to fill a spot in your calendar that is not served by our released/named varieties, contact MAIA about acquiring test trees of numbered selections that might meet your need.

Comment: "Let's expose some bookwork at the yearly meeting, financial statement"

Response: Full budgets are available on request. The board goes over the line items at a working meeting, usually in November. The books are submitted to an independent financial review each year.

Comment: "Hopefully we can make good money with this model. The other clubs require so much investment for a chance to roll the dice, and the investment is all on the grower. I like this grower friendly model, keep doing it. THANKS!!"

Response: You are welcome.

There were many laudatory comments, both to the variety and to MAIA. Thank you, it encourages us to carry on. Thanks to all who returned a survey, please do it again this year.



EverCrisp. Photo credit: Wafler Nursery



MAIA variety development includes making controlled crosses, growing and evaluating seedlings, and grafting the most exciting selections..

And Now, A Word from our Science Committee!

The Science Committee of MAIA meets once annually to coordinate the ongoing research and development of new varieties. Our goals continue to be the development of apple varieties, suited and available to growers in the Midwest, which excite consumers and ideally are easier and more profitable to grow than current varieties.

Here is a recap of our last meeting. Dr. Diane Miller of The Ohio State University spoke of the MAIA “pipeline” through which research seedlings are selected and moved into testing and production. She then introduced several speakers who are actively using MAIA material in their research. Speakers included Dr. Greg Miller, who briefed us on the value of expanding the genetic apple resources in our breeding program; Dr. Jonathan Fresnedo-Ramirez, who spoke on possibilities in genetic screening of new apple material; Dr. Melanie Ivy, who detailed a screening protocol for summer diseases; and Andy Kirk, who presented juice quality traits for hard cider making. See elsewhere in this newsletter for more details on their subjects.

We also reviewed the step-by-step process of creating a new variety, and the needed resources for each step. This includes making crosses, growing seedlings, planting and raising seedlings to fruiting, and evaluating and selecting interesting seedlings for propagation.

The later stages of this process we call variety development. This is where more folks can get involved by growing the interesting crosses and winnowing out the elite ones from the very tasty chaff of ‘pretty good’ varieties. To keep track of the elites, we have developed a ‘playbook’ wherein available facts and opinions are gathered for each elite selection, including results of public tasting evaluations. This data assists the committee in finally selecting ‘Champion’ varieties, which move forward to becoming a named variety with attendant marketing efforts.

Not every champion need be an Evercrisp-type apple to be a winner for MAIA. How to promote niche varieties, such as u-pick and farm market specialties, continues to be discussed by our committee.

Brad Phillips

Science Committee Chairman

AB Phillips & Sons Fruit Farm, Berlin Heights, OH

The Increasing Value of the

MAIA Research Pipeline

The grower participatory MAIA research pipeline is becoming more valuable from many perspectives:

New varieties created:

We can say that the steps in the pipeline process (planning a cross, making the cross, growing seeds, growing seedlings, selecting among seedlings, creating 2nd test trees, growing 2nd test trees, evaluating 2nd test trees) arose 'organically', each step was the next step needed. That is, if 'organically' means Mitch Lynd holding the vision and initially requesting, prodding and encouraging others to get involved in the work. That basic pipeline process of creating and evaluating new selections has led to 8 varieties being patented and now marketed. As patenting and marketing were the next steps that were needed, and Bill Dodd has led that marketing effort. Growers are fully able to select varieties their clientele will seek when the selection criteria is based on sensory attributes. New varieties are the tangible value.

A compelling public interest story:

The participation and collaboration among growers to positively impact their future by being involved in some aspect of the pipeline is an exemplary story. The news articles and media coverage have been very positive. The MAIA is perking up public interest in apples. Being on the positive side of the news is valuable.



Dr. Diane Miller

Department of Horticulture and Cop Science,
The Ohio State University

Essential for Midwest orcharding survival:

While in the past universities maintained tree breeding programs, that is not going to happen anymore as the actual process, even if important, is not new science. Having a grower group take on that 'routine', long-term process is both innovative and essential. New varieties containing traits such as the flavor and crispness that consumers seek are not going to fall out of the sky. As painful as it is to hear, after Honeycrisp came along, almost every other apple in your orchard was obsolete. Now the MAIA has an array of apples throughout the season with very crisp texture and pleasing flavors. EverCrisp is obviously the flagship but there are many others which will very pleasingly fill seasonal weekend niches. It will be up to you, the grower, to get the right assortment of these planted for your market. These are apples that consumers will love at first bite, and seek out.

A new type of collaboration with university research:

As you will see from other articles in this research report, the MAIA pipeline allows university researchers to step in to problem solve (see Melanie Ivey disease susceptibility article) or to look at new product development (see Andy Kirk hard cider article) or even to improve the efficiency of the pipeline process (see Emma Bilbrey genomics/metabolomics article). After the project (read 'funding/grant') is concluded, the researcher steps back out; the MAIA gains the information and can make improved decisions from that knowledge gained. And critically, the MAIA maintains the stability of the pipeline (and the ownership of the germplasm) so that growers can benefit both short and long term. However, in moving the apple industry forward, there are many traits needed that cannot be screened for by growers evaluating fruit sensory attributes. So research collaboration involving expanded germplasm base and technology tools will make the MAIA impact much greater long term.

A bright future:

The MAIA must keep focused on maintaining the 'seed to selection' pipeline process. The pipeline is the heart and the future of the organization. It is not grant fundable and it requires technical effort and expertise. From its success thus far, a plethora of opportunities for innovation (in many directions) have emerged. My science advice to the MAIA is 'keep focused on the pipeline.'

Year 2:

Ohio Cider: Blending Tradition and Discovery for the Modern Market



Quick overview:

Hard cider may well be a marketable use for some apples associated with the MAIA breeding program, either value-added in-house or through sales to regional hard cider producers. We are evaluating a wide range of apple germplasm associated with the MAIA breeding program for its value in hard cider. The longer-term intent is to facilitate development of a quality 'hard cider type' associated with Midwest apples/orchards.

Rationale:

Many Midwest orchards are becoming destination locations. Adding a cidery, or hard cider sales, adds to the uniqueness, appeal and income of a destination location. In addition, regional hard cider brands provide a market for apples produced by local growers. European hard cider apples are not well adapted to Midwest growing conditions. In this research we are evaluating candidates from the MAIA collection, as well as a broad array of diverse apple germplasm (including Central Asian material), for attributes needed for quality hard cider. In the longer term we are working toward facilitating the development of a signature Midwest type of hard cider.

Objectives:

Our objectives are to 1) identify the value of existing and new Ohio grown apple varieties for artisanal hard cider, 2) collaborate with the MAIA to select unique Midwest cider varieties and 3) provide networking opportunities among Ohio apple growers and cider makers.

Procedure:

Peck quantities of fruit are harvested, pressed using a prototype 'one-bagger' Good Nature Press, and juice analyzed for pH, brix, titratable acidity (% and g/L) and phenolic compounds. Taste testing of fermented product was organized through the MAIA involving MAIA enthusiasts or affiliated hard cider/wine industry. Based on this information, the most promising genotypes for further work were identified.

Results:

201 pecks of apple samples were collected from MAIA test orchards (predominately White House Fruit



Top: OSU research assistant Nick Spurlock prepares cider samples for chemical analysis. **Second from top:** Cider enthusiasts taste and evaluate new varietal ciders. **Second from bottom:** Researcher Amy Miller shows off the variety of colors of new cider samples. **Bottom:** Preparing for a cider tasting event.

Farm, Canfield, OH; Lynd Fruit Farm, Pataskala, OH and Dawes Arboretum, Newark, OH) throughout the 2017 season and juice analyzed for attributes. 134 samples were fermented. There were 89 unique varieties fermented. 24 samples were analyzed at multiple harvest dates to determine impact of maturity on traits. Four MAIA tasting and networking events were conducted. From the results, a group of 30 apple genotypes were selected for their hard cider potential value. In 2018, those 30 are being evaluated at the scaled up 2 bushel level for juice traits and controlled fermentation traits and will be evaluated in the coming months by MAIA tasters.

Funding source: Ohio Department of Agriculture Specialty Crops Block Grant (2016-2018 and 2018-2020)

Acknowledgements: Special thanks to Twigg Winery (Augusta, OH), Bent Ladder Cider and Wine (Doylestown, OH), Quarry Hill Winery (Berlin Heights, OH), and Mad Moon Craft Cidery (Columbus, OH) for their assistance with this project.

Andy Kirk
Ashtabula Agricultural Research Station,
The Ohio State University

Dr. Diane Miller
Department of Horticulture and Cop Science,
The Ohio State University



Above, left: Researcher Andy Kirk presses small batches of cider from MAIA test selections. **Top right:** Cider sample, standardized flavor wheel, and data sheets. **Center and bottom right:** Cider enthusiasts taste and evaluate new varietal ciders.



Host Resistance of MAIA Cultivars to Fungi that Cause Summer Fruit Rots

Quick overview:

Fruit rot susceptibility is becoming a huge economic issue in Midwest orchards as summer temperatures and moisture increase. In this study we are evaluating the susceptibility of MAIA variety releases to fruit rots.

Rationale:

Three fungal diseases that commonly occur on apples during the summer are black rot, bitter rot, and white rot. In addition, brown rot can cause late season fruit rot. Good orchard and tree sanitation and fungicides applied from first cover until harvest on a 2-week schedule are generally effective. However, fruit that are infected by these fungi shortly before harvest can also develop decays during storage. Host resistance can vary among cultivars, but no cultivars are known to be resistant. The susceptibility of newly released and soon to be released cultivars by the Midwest Apple Improvement Association (MAIA) is not known. Knowledge of the range of host resistance among these new cultivars will allow for the development of improved pre- and post-harvest management programs.

Objective:

The objective of this study is to determine the level of host resistance in MAIA apple cultivars.

Procedure:

MAIA apple cultivars will be evaluated for resistance to black rot, bitter rot, white rot and, brown rot. Ten apples of each cultivar will be surface sterilized, wounded or not wounded and inoculated with the fungal pathogen associated with each disease. In addition, ten non-inoculated apples (wounded or not wounded) of each cultivar will serve as the negative controls. Following inoculation, the apples will be incubated at conditions that favor disease development. Apples will be rated daily for disease by measuring the diameter of the lesion on each apple. Susceptibility to each disease will be scored using an ordinal scale based on lesion diameter.

Funding source: Ohio Apple Marketing Program

Dr. Melanie Lewis Ivey and Rachel Medina
Department of Plant Pathology, College of FAES
The Ohio State University

Left: Various types of summer fruit rot on MAIA cultivars.

Linking Apple Genomics and Metabolomics for Germplasm Improvement

Quick overview:

We aim to develop a platform that will enable plant breeders to generate apple varieties more efficiently and with enhanced nutritional qualities and sensory properties. This platform will integrate data about the beneficial phytochemicals and the genetics of apples. An OSU graduate student, Emma Bilbrey, will conduct her master's research within this project.

Rationale:

If apple breeders had the ability to identify genes related to specific metabolites of interest (whether for improved nutrition, flavor or texture), they could more efficiently screen seedlings for genes of interest and market cultivars based on nutritional attributes. Apple breeding is a long-term effort. Any screening that can be done at the early seedling stage to identify candidates containing desired traits (and remove candidates lacking desired traits) would result in higher value field plantings from which apple varieties can be selected. For example, by genomic screening, a population of 10,000 seedlings might be reduced to a population of 100 seedlings if several traits were all required in the screening. We are using apple to develop and prove the concept of using genomics to screen for health beneficial compounds.

Objectives:

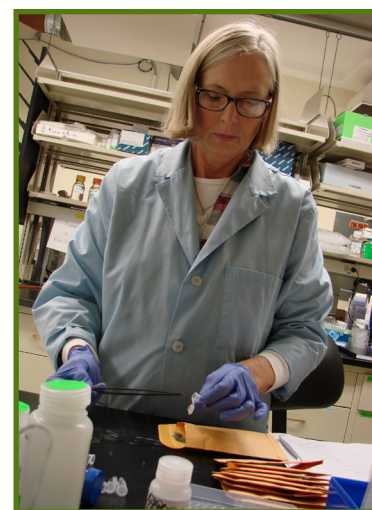
- 1) Extract DNA to genotype selections from three overlapping apple families that have diverse flavor and texture (DNA extraction from leaves)
- 2) Analyze the metabolites (especially health beneficial compounds) in the fruit of these families using both UHPLC-MS and NMR untargeted metabolomics
- 3) Integrate the genomics and metabolomics data for future development of laboratory screening techniques of young seedlings for desired germplasm improvement

Procedure:

Fruits from MAIA progenies of the crosses Honeycrisp x Goldrush; Goldrush x Sweet 16; and Honeycrisp x Fuji and their parents are being analyzed in this study. These progenies contain diverse flavors, textures, consumer appeal and seasonality of ripening. In the fall of 2018, fruit were collected and fruit samples frozen in liquid nitrogen and stored at -20C. Using fruit tissue, untargeted metabolomics employing UHPLC-MS and NMR spectroscopy will produce metabolite profiles for phytochemicals in the fruits. From leaf samples, collected from these same trees in summer 2018 and freeze dried, DNA is being extracted. Single nucleotide polymorphism (SNP) arrays will produce genotypic data for comparison among progenies and cultivars in the pedigree. The genomic and metabolomics data will be integrated using a pedigree-based analysis approach for the identification of quantitative trait loci (QTL), and thus to interrogate the putative genes influencing traits.

Funding source: This work is supported by a seeds grant from Foods for Health, a focus area of the Discovery Themes Initiative at The Ohio State University.

Emma Bilbrey, Drs. Jessica Cooperstone,
Joanthan Fresnedo-Ramirez, Emmanuel Hatzakis, Diane Miller
College of Food, Agriculture, and Environmental Sciences, The Ohio State University



OSU lab technician Cheri Nemes extracts DNA from apple leaves.



OSU student worker Maryssa Starman freezes samples for analysis.



OSU Master's student Emma Bilbrey and student worker Maryssa Starman harvest MAIA test apples.

Stepping Up the Mission:

Disease-Resistance, Frost-Tolerance, and More

The MAIA has been successful in selecting a number of truly outstanding apple cultivars. They are primarily outstanding in terms of apple quality, with apple qualities that are truly game changers. Who knew apple breeding was so easy? The key to creating these cultivars was combining the right parents, especially genetically complementary parents. Choosing the right parents probably involved some luck, but it also benefited from a long history of apple breeding. For example, a lot of time, money, and human effort went into creating Fuji, Honeycrisp, Goldrush, and Sweet 16, and into creating their ancestors. These highly selected parents were full of good genes and couldn't help it but to produce good offspring. Now the question is, can we just keep crossing the best selections and get even better offspring? Well, we're on the path of finding out. At the moment, we are generating an array of really good apples with different qualities and ripening times, but the recent selections aren't a whole lot better than the earlier selections. The advantage of using really good parents is that it's easy to get really good offspring. The downside is that we soon get to a point where this is as good as it's going to get. We might be there already.

The MAIA has also been successful in developing a grower-directed apple breeding program: an institution, a business model, infrastructure, and germplasm. It's a system that is really working. It not only generates outstanding apple cultivars, it generates enthusiasm and enjoyment. It's also a system that is growing and changing.

As such, there is a critical need for proper strategic decisions. Basically, where do we go from here and how do we spend our money?

With fruit quality of new releases already at a high level, the MAIA has now also embarked on the long-term effort of combining high fruit quality with high growing qualities such as disease and insect resistance, high and

low temperature tolerance, tree form and cropping characteristics, etc. There is considerable room for improvement in these characteristics. And importantly, the MAIA already has assembled the genetic resources that will allow substantial gains in growing characteristics. Thanks mainly to the efforts of Dr. Diane Miller, the MAIA has grown, fruited, and evaluated thousands of wild apple seedlings comprising 3 species from Kazakhstan and Kyrgyzstan. Plus, Diane has imported (pollen) and incorporated new highly disease resistant material from Switzerland. The central Asian material and the Swiss material exhibit an exciting array of disease resistances, frost and cold tolerances, flowering habits and times, growth characteristics, and probably other not-yet-evaluated char-



acteristics such as insect resistance and root (rootstock) characteristics. In addition, the central Asian material exhibits new and unique flavors, textures, and fruit shapes. The downside of all these exciting characteristics is that they are housed across a number of different individuals and these individuals also carry a sizeable genetic load of undesirable characteristics. To get all the good characteristics combined into individuals (ultimately cultivars) it will

take several generations of controlled crosses and evaluations of thousands of seedlings. This will require a substantial financial and time commitment by the MAIA and the willingness of growers to provide the necessary land and care of seedlings. The tedious process of combining traits and selecting potential cultivars can be greatly enhanced and sped up with the use of genomics tools and other sophisticated evaluation methods available through university researchers and private labs. The long-term commitment to the field work of this program by the MAIA will likely enable university researchers to secure grant money for the supporting lab work. In other words, if the MAIA wants to gain support from university researchers, it needs to support the long-term field work. Ultimately, it will be apple growers who benefit from the MAIA and university collaboration.

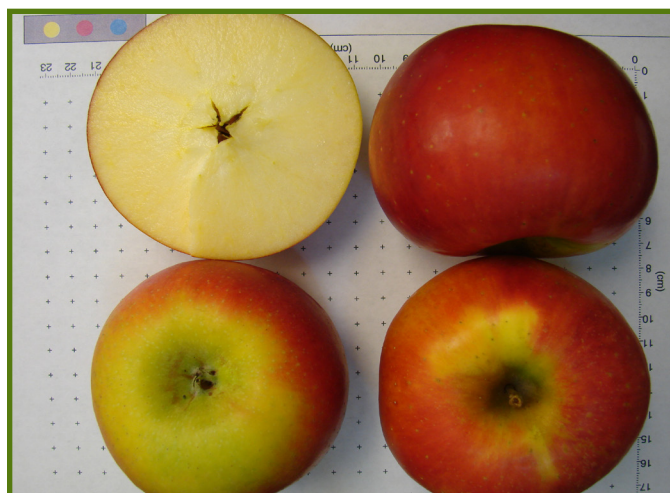
Summing up where the MAIA is at this point:

- Has assembled a broad genetic base of world-class germplasm.
- Has developed a grower-based system of making and growing large numbers of seedlings.
- Has developed an innovative selection system that utilizes grower knowledge and consumer preference evaluations.
- Has partnered with a nursery and with growers to make and evaluate 2nd test trees.
- Has developed a marketing system to monetize releases.
- Has clout with academics who can speed up the breeding and selection process with genomics tools and other lab-based tools.
- Now has an income stream sufficient to continue all of the above long enough to accomplish the goal of providing the next step of robust, high-quality apple cultivars for Midwest growers.

The critical step that's needed at this point is for the MAIA to commit sufficient resources to this auspicious endeavor. The MAIA already has the resources; it just needs the will to step up the mission.

Dr. Greg Miller

Empire Chestnut Company, Carrollton, OH
Tree breeding advisor to MAIA



Opposite and above: The MAIA has a wealth of untapped genetic diversity waiting to be explored.

