

Title: From Ground to Glass: Evaluation of unique barley varieties for western Washington craft malting, brewing and distilling

PI: Stephen Bramwell

Co-PI: Kevin Murphy

Co-PI: Tom Collins

Cooperators

Evan Mulvaney, Hidden River Farms. Evan owns and operates Hidden River Farms (<http://www.hiddenriver.farm>), an 88 acre grain, vegetable and sustainable pork operation on the Wynochee River near Montesano, WA. He is providing use of 5 acres of farmland for the field trials. Evan will conduct field preparation operations, apply fertilizer, seed the plots, and provide weed control measures such as tine cultivating. Evan is not responsible for plot harvest.

John Bourdon, Sandstone Distillery. John is the owner of a private craft distillery (<http://www.sandstonedistillery.com/>) in Tenino, WA, whose spirits have won multiple prestigious awards; for vodka (2016 Silver Medalist American Craft Spirits Association, 2016 Bronze Medalist Seattle International Spirits Awards) and whiskey (Winner of the Seattle International Spirits Competition Double Gold Medal & SIP Magazine's Best of the Northwest). His role in this project is to utilize the nine barley cultivars to distill batches of single-cultivar unaged whiskey for distillate and end-use analysis.

Dr. Tom Collins, Wine & Distillate Science Specialist, WSU Viticulture and Enology. Tom is a world expert in analytical chemistry and analyses of the distilling process, and leads a cutting edge program at the new Ste. Michelle Wine Estates WSU Richland Wine Science Center (<http://wine.wsu.edu/faculty/tom-collins/>). He will provide technical expertise and oversight of distillate analysis, sensory assessment, and statistical analysis of GC-MS data.

Abstract

Looking for biological tools to interrupt pest and disease cycles in vegetable-intensive systems, and additional opportunities for value-added feed, brewing and distilling grain, farmers in western Washington are interested in integrating cereal crops into farm operations. This study will utilize a breeder-extension-farmer-craft brewer/distiller collaboration to evaluate barley varieties for organic production and value-added processing. We hypothesize that unique flavors exist among the diverse germplasm in the WSU barley breeding program that will be of interest to craft maltsters, brewers and distillers. Nine barley breeding lines and/or varieties will be evaluated for valuable agronomic and end-use characteristics important to maltsters, brewers, distillers and farmers. This project specifically catalyzes WSU faculty engagement with BIOAg principles by 1) publishing agronomic data that supports biologically intensive crop rotations such as grain-vegetable integration, 2) evaluating barley production and end-use characteristics under explicitly organic management, and 3) utilizing a three-legged approach to sustainable agriculture by developing novel marketing opportunities, providing ecological crop rotation tools for managing pest populations, and spurring social engagement between farmers, processors, and consumers. Project impacts include the potential for immediate release of new WSU

barley varieties for the first time specifically suited to the needs of craft brewers, micro-maltsters, and local distillers. Farmers will gain vital agronomic information about locally-adapted varieties when integrating barley into crop rotations. Additionally, this research will leverage funding for sensory evaluation events, demonstrating to decision-makers, processors, farmers, and consumers the potential of regional organic barley production for value-added markets.

Introduction/literature review

Justify using relevant literature why this project is important and is the next logical step in implementing change. Include economic justification to demonstrate the value of the proposed work. (approx 4050 characters and spaces combined; confirm fit without scrolling)

Reintroduction of grain production in minor growing regions has been promoted to give non-grain farmers biological tools for managing pests and disease, and to develop marketing relationships among farmers, craft brewers and craft distillers (1, 2, 3). Western Washington has been shown to be a unique agro-ecosystem for the union of regional grain production and end-use product development (4, 5). However, expansion of specialty grain production may depend on development and successful marketing of novel attributes. The current proposal addresses specific literature gaps regarding 1) identification of suitable barley cultivars for production and craft brewing and distilling in western Washington, and 2) the impact of barley cultivar on novel flavor attributes in craft beverages.

The proposed work extends WSU breeding efforts through field-scale evaluation of barley cultivars for craft brewing and distilling. Ongoing breeding efforts at WSU identify barley lines suited to grain production in western Washington while exhibiting specific quality characteristics, predominantly for malting and recently for distilling. Breeding for malting cultivars has historically focused on lines suitable for adjunct brewing, in which malted barley is supplemented by rice or corn. These breeding programs serving large-scale adjunct brewing have emphasized high diastatic power (DP), high free amino nitrogen (FAN) cultivars (6). In adjunct brewing, high DP barley is necessary because malted barley drives enzymatic conversion of carbohydrate to alcohol. In contrast, all-malt (all barley) brewing employed by craft brewers can rely on lower DP varieties, and variations in other traits. Characteristics evaluated by the WSU breeding program, and important to craft brewers, include malt quality, percent malt extract, lower DP and FAN, beta glucan content, germination energy, water sensitivity and falling number. Breeding work utilizing these evaluation criteria has identified promising lines that, grown out for field-scale evaluation in the current study, will allow for full-scale evaluation of distilling and brewing characteristics.

Agronomic traits important in the evaluation of barley cultivars for western Washington include grain yield, resistance to foliar diseases, and lodging. Lines that the current work would advance to field-scale and end-use evaluation include the new WSU cultivars Muir and Havener, and seven advanced breeding lines. All these lines have been tested for years over multiple environments (including western Washington), and are poised for varietal release, followed by distribution to growers.

The proposed work will also evaluate barley cultivars for craft distillers. Few studies are available that ask the question addressed in this proposal: does barley cultivar impart detectable differences in new make (un-aged) spirits. Rapid growth of the craft distilling industry has created substantial interest in the effect of barley cultivar on distillate. As with craft brewers, craft distillers express interest in the potential of local variation to develop terroir to distinguish craft products, climatic conditions, seasonal variation, and growing region.

Collins et al. (8) report on differences among *aged* whiskeys based on blending, point of origin, grain type and spirit type, whereas evaluation of cultivar influence on distillate should focus on new make product to separate barrel aging from cultivar differences. New make (white) whiskey is suggested as a better spirit for evaluating cultivar effects than vodka, as lower proof distillate allows greater retention of feedstock character. Ng et al. (9) report on differentiation of Canadian and American (unaged) vodkas based on GC-MS volatile analysis. They do not report on influence of cultivar specifically, but do report that raw materials, manufacturing and additives were responsible for differences, suggesting specific investigation of cultivar impacts as a logical next research step.

With estimated \$10.5 million in annual whiskey sales in Thurston County, 7.5 percent (grain value per bottle) of this value on 25 percent of sales would direct \$20,000 in sales across ten County farmers.

Objectives

1. Identify barley varieties with strong agronomic characteristics, high yields, and disease resistance under local growing conditions in south Puget Sound region of western Washington
2. Generate volume of each barley variety to evaluate for craft malting, brewing and distilling
3. Determine whether cultivar affects flavor in new-make craft spirits
4. Demonstrate contributions of grain production and processing to the local economy through community agri-tourism events that feature value-add opportunity for the agricultural economy
5. Build public understanding of local grain production and processing opportunities/constraints by convening audiences that are not exposed to distilling on the one hand and production agriculture on the other

Procedures

Nine barley varieties will be grown out and evaluated on half-acre plots at Hidden River Farms, an organically managed grain and hog operation. Breeding lines (numbered) and varieties (named) selected for this evaluation include two hulless types (Havener, X05013-T1) and seven hulled types (Muir, 10WA-117.24, 10WA-117.17, 11WA-107.43, 11WA-107.58, 12WA-120.14, 12WA-120.17). Unnamed varieties are WSU breeding lines. The named cultivars will be used as 1) check cultivars and 2) an immediate product that is available for growers. Selected barley varieties are 2-row types with low to moderate beta glucan and protein content and possess many quality traits which make them excellent candidates for malting. In particular, Muir has performed well in organic systems in western Washington, and is one of the most stripe rust resistant varieties available. Evaluation of Muir in south Puget Sound will provide useful agronomic information for farmers, as this variety can also be a source of animal feed for this growing region.

Field preparation for the trials will consist of manure and lime applications based on soil test results, followed by primary and secondary tillage with a tillage disk and disk harrow. Plots will be approximately 100 feet wide by 200 feet long, and will be sown with fifty pounds of barley (100 pounds per acre) provided by the WSU barley breeding program. Anticipated minimum yield per half-acre plot is one thousand pounds (one ton per acre). Average cooperativer barley yield is 1.5 tons per acre. The field will be managed per standard local practice among organic grain farmers. Soil in the five-acre trial field is uniformly Chehalis silt-loam, a fine-silty, mixed, superactive, mesic Cumulic Ultic Haploxerolls (NRCS, 2016). Plot fertility will be assessed with spring soil testing, and maintained for yield yet low grain protein, which is inversely related to alcohol yield. In 2015, organic wheat was grown on the entire area, with uniform fertility applications and management practices.

Agronomic performance of the selected varieties will be evaluated for production potential in western Washington based on plant height at anthesis (cm), heading date (from January 1), barley stripe rust (% leaf infected), lodging (percent of plot area) and yield (kg ha⁻¹ clean grain on basis of harvested plot area). Barley varieties will be sent to the USDA Grains Research Program in Madison, WI to evaluate for malting quality based on kernel weight (mg), plump (% retained on 6/64" screen), barley color (Agron), malt extract (%), wort color, wort clarity, barley protein (%), wort protein (%), protein modification or S/T (%), DP (ASBC), alpha amylase (20 DU), beta glucan (ppm), and FAN (ppm).

Upon harvest, six of nine varieties will be selected for micro-distillation into new make whiskey by craft distilling cooperator Sandstone Distillery. A micro-distillation requires 500 pounds of grain while micro-malting requires 150 pounds. The current study will utilize one distillation run for six selected varieties or two separate (replicated) distillation runs for three varieties (yield will impact available grain for distillation reps); similarly, two separate (replicated) micro-malting runs (300 pounds grain total) will be completed for each of all nine varieties. Half-acre plots yielding one thousand pounds each will provide sufficient grain for one micro-distillation and replicated micro-malt test batches of each variety; yield of 1,600 pounds per plot (farm cooperator average) would allow replicated distillation. Distillate analysis will consist of laboratory evaluation of new make product using gas chromatography-mass spectrometry (GC-MS) and sensory evaluation using a tasting panel at the WSU Wine Science Center. GC-MS methodology developed by project partner Tom Collins will be utilized per accepted standards (8, 10). GC-MS results for each of the nine varieties will be compared against two controls, an award winning white (unaged) whiskey made by Sandstone Distillery, and White Dog, an all-barley white whiskey made by House Spirits Distillery in Portland, OR. Micro-distillation will be conducted by Oregon State University in a recently established micro-malting facility in Corvallis, OR. Three hundred pound samples of nine barley varieties sent the OSU facility will be evaluated for malting and brewing characteristics including free water, germination energy and water sensitivity, critical metrics associated with malting quality.

Distillate sensory evaluation will utilize a trained tasting panel at the WSU Wine Science Center. A detectable differences methodology (triangle test) will be used in which panelists taste three samples, two of the same spirit and one different. Reliable difference detection is determined on the basis of panelists differentiating the two same from the one different sample. Where repeatable differences are detected between varieties, panelists develop descriptions that facilitate differentiation based on aroma and flavor. These can be linked to specific associated chemical compounds, such as ethyl esters imparting "fruity" odors (10), among other attribute-compound associations.

Outputs – products or activities

- Agronomic data: Extension bulletin – Growing barley in western Washington for craft brewing, distilling and livestock feed
- Barley malting data :Extension publication – Ground to glass; barley varieties for craft brewing
- Project results will be presented at the Cascadia Grains Conference
- Community sensory evaluation, public agri-tourism event with City of Tumwater and Visitor and Convention Bureau; community sensory presentation
- Distillate analysis: conference proceeding at Cascadia Grains Conference and extension publication – Growing and marketing barley for the craft brewing and distilling industry
- Field day: western Washington barley production for craft brewing, distilling and feed
- Refereed scientific journal as data permits

Impacts

Short-term

- 30 growers attend field days and are aware of opportunity to grow barley in western WA
- 10 local government decision-makers more aware of brewing/distilling using local grain
- Growers have agronomic information about performance of available barley varieties
- Growers and craft brewers, distillers have end-use data on available barley varieties
- Research results used in ongoing grain mill feasibility study with local land trust
- Farmer are interested in grain network, want to experiment with integrating grain-veg-livestock

Medium term

- 15 Local brewers/distillers/feed purchasers are provided research result publications
- Brew/liquor from local barley featured in three regional agri-tourism marketing materials
- 100 community members attend events, increase awareness brewing/distilling with local grain
- Local craft brewing and distilling initiative in City of Tumwater uses information to promote development of Craft Brewing and Distilling Center
- Consumers are willing to pay a small premium for local craft beer, spirits
- One local distillery regularly sources organic barley
- Local agri-tourism organizations (VCB) and jurisdictions (City of Tumwater) are interested in matching funds to support community sensory panel agri-tourism event

Long-term

- Ed material on organic barley for Craft Brewing-Distilling available through WSU
- Integrating grain into crop rotation including in cultivating success advanced course
- Small-scale grain mill is established for mixing feed, brokering sales
- A local grain equipment cooperative is established to farms to integrate grain production
- Barley is used in intensive vegetable crop rotation for feed and brewing-distilling to close nutrient loops, integrate crops-livestock, and break pest and disease cycles
- A field trial is established to evaluate the impact of grain-vegetable crop rotation on specific pest and/or disease severity or population
- One south Puget Sound distillery, brewery, and feed store regularly source a barley variety f this or subsequent grain variety trial linked to this project

Evaluation

This project will use an evaluation approach described by Taylor-Powell et al. (21), which provides a framework to systematically identify evaluation objectives, users, questions, and indicators. This approach utilizes the Bennett hierarchy to identify evaluation questions and indicators at multiple program levels, including resources invested, activities, participation, reactions, learning, actions, and, impacts. Specific evaluation indices will be used to gauge the success of project implementation as well as results, including information gained by participants, utilization of that information and potential for economic, social and environmental change. Examples of evaluation indices include number of activities (field days, informational resources developed), participation measures (field attendance, downloaded materials), catalyzed actions (use of information), evaluations of extension events, and application of information (quantity of evaluated varieties sown, transacted).

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