

Jared Crain, Ph.D.

jared.l.crain@gmail.com 785-477-5872

402 Beagle Club Road, Lewisburg, Pennsylvania 17837

Education:

- Doctor of Philosophy in Genetics 2016
Kansas State University, Manhattan, Kansas
Advisor: Dr. Jesse Poland
Dissertation: *Leveraging the Genomics Revolution with High-Throughput Phenotyping for Crop Improvement of Abiotic Stresses*
- Master of Science in Plant and Soil Science 2012
Oklahoma State University, Stillwater, Oklahoma
Advisor: Dr. Bill Raun
- Bachelor of Science in Plant and Soil Science 2010
Oklahoma State University, Stillwater, Oklahoma
Soil Science Option, Biochemistry Minor

Research Activities:

- Postdoctoral Researcher, Kansas State University June 2016-present
- Intermediate Wheat Grass Breeding and Genomics
 - Evaluated intermediate wheatgrass yield with mixed models accounting for spatial location and family effects
 - Reduced breeding cycle time 50% through genomic selection
 - Realized greater than 10% genetic gain for target traits in intermediate wheatgrass breeding
 - Database developer and administrator for intermediate wheatgrass project
 - Developed pipeline for genomic selection breeding in intermediate wheatgrass to operate within two-week time constraint
 - Prepared research results for peer-reviewed publications and presentations
 - Field-based high-throughput phenotyping
 - USDA-NIFA Principal Investigator (PI) for single plant association mapping trial
 - Project management and NIFA reporting
 - Evaluated yield of single plants compared to full plot yields
 - Development of methods to predict plot yield from single plant yield
 - Prepared research results for peer-reviewed publications and presentations
 - Mentoring and training
 - Two-week intensive genomic selection and genome wide association analysis workshop
 - Mentor undergraduate student research project
 - Advise graduate students on data analysis and interpretation

Graduate Research Assistant, Kansas State University 2012-2016

- Conducted research in high-throughput phenotyping and genotyping-by-sequencing for quantitative trait analysis
- Identified 12% increase in genomic prediction accuracy using multivariate genomic selection model compared to univariate model
- Applied nonlinear logistic growth models to evaluate wheat growth
- Mixed model application to wheat yield for multiple location and year field trials to determine data quality and develop selection methods
- Development of data management pipelines to manage millions of phenotypic data collected throughout the growing season
- Developed and evaluated novel phenotyping platforms

Graduate Research Assistant, Oklahoma State University 2011-2012

- Led evaluation of OSU NDVI Pocketsensor, commercialized as Trimble GreenSeeker Handheld Crop Sensor
- Data management with Microsoft Office and SAS
- Data collection and sample preparation for nutrient use efficiency
- Experience with corn, wheat, cotton, and soybean crop trials

Teaching Activities:

Graduate Teaching Assistant, Kansas State University Fall 2014

- Assisted with undergraduate/graduate co-listed course, Plant Genetics
- Lectured on DNA sequencing and genetic mapping populations
- Prepared and graded homework assignments and exams

Student-Athlete Tutor, Kansas State Athletics Fall 2012, Fall 2013

- Worked with students to prepare for exams in agriculture, biology, economics, mathematics, and statistics
- Assisted students with maintaining satisfactory classroom progress
- Provided feedback to students through graded assignments

United States Fulbright Scholar: 2010-2011

- García Robles Scholar to Mexico
- Worked with scholars and farmers from around the world
- Delivered presentations in English and Spanish

International Experience: 2007-2016

- Strong Spanish communication skills
- Worked and traveled extensively in Mexico

Invited Presentations:

University of Minnesota Forever Green Initiative 2021
 “The Land Institute Genomic Selection Update”

ETH Zurich Molecular Plant Breeding Group 2021

“Genomic Selection to Enhance Domestication and Agronomic Performance in Intermediate Wheatgrass”

University of Minnesota Forever Green Initiative “Genomic Selection to Improve Domestication Breeding Efficiency”	2020
University of Nebraska Lincoln Plant Breeding and Genetics Symposium “Combining High-Throughput Phenotyping and Genomic Information to Increase Prediction Accuracy in Wheat Breeding”	2016
Oklahoma State University Department of Plant and Soil Sciences Seminar “Combining Next Generation Sequencing with High-Throughput Phenotyping for Quantitative Trait Dissection”	2014

Technical Skills:

Genetics and Plant Science: high-throughput phenotyping • genomic selection • plant breeding • genome wide association studies • QTL analysis • small plot research fieldwork • phenotyping platform development and evaluation • analysis of unbalanced field trials • quantitative genetics • plant physiology

Statistical Analysis: linear models • nonlinear models • design of experiments • mixed models • principal component analysis and regression • spatial statistics • applied multivariate models

Software: R • SQL • Perl • Bash Scripting

Languages

- English (*native*)
- Spanish (*proficient working*)

Activities:

Oklahoma FFA Northwest District Vice President	2006-2007
Oklahoma Agriculture Leadership Encounter Class V	2007-2008
Oklahoma FFA Leadership Camp Staff	2006-2010

Fellowships:

Gerald O. Mott Meritorious Graduate Student Award	2015
Monsanto’s Beachell-Borlaug International Scholars Program Awardee	2012
United States Fulbright Awardee	2010

Honors and Awards:

Outstanding Reviewer <i>The Plant Genome</i>	2020
Inaugural Outstanding Paper, <i>The Plant Genome</i>	2020
GENETICS Peer Review Training Program	2019
Outstanding Reviewer <i>Crop Science</i>	2018

Finalist the Data Incubator	2017
Finalist Kansas State University 3 Minute Thesis Competition	2016
Edgar S. McFadden Poster Presenter	2016
Oklahoma State University Phoenix Award for Outstanding Master's Student	2012
Oklahoma State University Outstanding Senior	2010

Service:

Ad hoc reviewer for Agronomy Journal, Crop Science, Genes|Genomes|Genetics, Genetics, Grassland Science, Heredity, Plant Molecular Biology Reporter, The Plant Genome, The Plant Phenome Journal, Plant Physiology, and Theoretical and Applied Genetics.

SCHOLARLY ACTIVITY SUMMARY:

17 published peer-reviewed journal articles, 3 submitted grant applications with funding as Principal or Co-Principal Investigator of \$1,296,838.59, 5 open source data sets and scripts, 1 book chapters, 1 teaching module, and 23 abstracts.

Grant Funding:

1. Jungers, J., Anderson, J., Annor, G., Bajgain, P., Bartel, C., Basche, A., Bell, M., Brunzell, N. Carlson, C., Clark, W., **Crain, J. (Key Personnel)**, Crews, T., Culman, S., Cureton, C., Dawson, J., DeHaan, L., Engelskirchen, G., Eshenaur, T., Farag, J., Geenstra, G., Fernholz, C., Gutknecht, J., Ismail, P., Jordan, N., Keaveny, T., Keene, C., Kimber, T., Labowski, C., Mayerfeld, D., Meirer, E., Moore, R., Morse, S., Peener, B., Peters, T., Picasso, V., Poland, J., Pratsch, Priske, J., Priske, D., Reser, A., Schriefer, G., Sheaffer, C., Singleton, T., Stoltenber, D., Streit Krug, A., Stroer, R., Tautges, N., Trost, J., Wiegert, C., & Wyse, D. (2019). Developing and deploying a perennial grain crop enterprise to improve environmental quality and rural prosperity. Sustainable Agricultural Systems, Coordinated Agricultural Project.
2. Anderson, J., Bajgain, P., DeHaan, L., **Crain, J. (CoPI)**, Larson, S., Poland, J., & Turner, K. (2019). Innovations in plant genetics to develop intermediate wheatgrass as a next-generation sustainable crop. Seeding Solutions Foundation for Food and Agriculture Research (FFAR). Funded for \$996,838.59.
3. **Crain, J. (PI)**, & Poland, J. (2018). Unified big data in genomics and phenomics for plant breeding. NSF Early Concept Grants for Exploratory Research (EAGER). Funded through the Agriculture and Food Research Initiative Competitive Grant no. 2019-67013-29008 from the USDA National Institute of Food and Agriculture for \$300,000.

Peer-Reviewed Articles:

1. **Crain, J.**, Haghghattalab, A., DeHaan, L., & Poland, J. (2021). Development of whole-genome prediction models to increase the rate of genetic gain in intermediate wheatgrass (*Thinopyrum intermedium*) breeding. *The Plant Genome*. e20089.

<https://doi.org/10.1002/tpg2.20089>

2. **Crain, J.**, DeHaan, L., & Poland, J. (2021). Genomic selection enables rapid selection of high-performing genets in an intermediate wheatgrass (*Thinopyrum intermedium*) breeding program. *The Plant Genome*. e20080. <https://doi.org/10.1002/tpg2.20080>.
3. Altendorf, K., Larson, S., DeHaan, L., **Crain, J.**, Neyhart, J., Dorn, K., & Anderson, J. (2021). Nested association mapping reveals the genetic architecture of spike emergence and anthesis timing in intermediate wheatgrass. *G3 Genes|Genomes|Genetics* <https://doi.org/10.1093/g3journal/jkab025>.
4. **Crain, J.**, Larson, S., Dorn, K., Kantarski, T., DeHaan, L., & Poland, J. (2020). Sequenced-based paternity analysis to improve breeding and identify self-incompatibility loci in intermediate wheatgrass (*Thinopyrum intermedium*). *Theoretical and Applied Genetics* 133(11), 3217-3233.
5. **Crain, J.**, Bajgain, P., Anderson, J., Zhang, X., DeHaan, L., & Poland, J. (2020). Enhancing crop domestication through genomic selection, a case study of intermediate wheatgrass. *Frontiers in Plant Science* 11, 319.
6. Larson, S., DeHaan, L., Poland, J., Zhang, X., Dorn, K., Kantarski, T., Anderson, J., Schmutz, J., Grmiwood, J., Jenkins, J., Shu, S., **Crain, J.**, Robbins, M., & Jensen, K. (2019). Genome mapping of quantitative trait loci (QTL) controlling domestication of intermediate wheatgrass (*Thinopyrum intermedium*). *Theoretical and Applied Genetics* 132(8), 2325-2351.
7. DeHaan, L., Christians, M., **Crain, J.**, & Poland, J. (2018). Development and evolution of an Intermediate Wheatgrass domestication program. *Sustainability* 10, 1499.
8. ¹**Crain, J.**, Mondal, S., Rutkoski, J., Singh, R., & Poland, J. (2018). Combining high-throughput phenotyping and genomic information to increase prediction and selection accuracy in wheat breeding. *The Plant Genome* 11(1), 1-14.
9. Lamsal, A., Welch, S. Jones, J., Boote, K.J., Asebedo, A., **Crain, J.**, Wang, X., Boyer, W., Giri, A., Frink, E., Xu, X., Gundy, G., Ou, J., & Arachchige, P.G. (2017). Efficient crop model parameter estimation and site characterization using large breeding trial data sets. *Agricultural Systems* 157, 170–184.
10. Haghghattalab, A., **Crain, J.**, Mondal, S., Rutkoski, J., Singh, R.P., & Poland, J. (2017). Application of geographically weighted regression to improve grain yield prediction from unmanned aerial system imagery. *Crop Science* 57(5): 2478–2489.
11. **Crain, J.**, Reynolds, M., & Poland, J. (2017). Utilizing high-throughput phenotypic data for improved phenotypic selection of stress adaptive traits in wheat. *Crop Science* 57(2): 648–659.

¹2020 Outstanding Paper for *The Plant Genome*

12. **Crain, J.**, Wei, Y., Barker, J., Thompson, S.M., Alderman, P.D., M. Reynolds, N. Zhang, and J. Poland. (2016). Development and deployment of a portable field phenotyping platform. *Crop Science* 56(3): 965–975.
13. Mohammed, Y.A., Raun, W., Kakani, G., Zhang, H., Taylor, R., Desta, K.G., **Crain, J.**, Mullock, J., Bushong, J., Sutradhar, A., Ali, M.S., & Reinert, M. (2015). Nutrient sources and harvesting frequency on quality biomass production of switchgrass (*Panicum virgatum* L.) for biofuel. *Biomass and Bioenergy* 81, 242–248.
14. Kelly, J.P., **Crain, J.**, & Raun, W.R. (2015). By-plant prediction of corn (*Zea mays* L.) grain yield using height and stalk diameter. *Communications in Soil Science and Plant Analysis*, 46(5), 564-575.
15. **Crain, J.**, Waldschmidt, K.M., & Raun, W.R. (2013). Small-Scale Spatial Variability in Winter Wheat Production. *Communications in Soil Science and Plant Analysis*, 44(19), 2830–2838.
16. Edmonds, D.E., Tubaña, B.S., Kelly, J.P., **Crain, J.**, Edmonds, M.D., Solie, J.B., Taylor, R.K., & Raun, W.R. (2013). Maize Grain Yield Response To Variable Row Nitrogen Fertilization. *Journal of Plant Nutrition*, 36(7), 1013–1024.
17. **Crain, J.**, Ortiz-Monasterio, I., & Raun, B. (2012). Evaluation of a Reduced Cost Active NDVI Sensor for Crop Nutrient Management. *Journal of Sensors*, 2012, 1–10.

Submitted Articles:

1. Rahman, M.M., **Crain, J.**, Haghghattalab, A., Singh, R.P., & Poland, J. Improving wheat yield predictions using secondary traits and high-density phenotyping under heat stressed environments. *Frontiers in Plant Science*.
2. Jones, T., Monaco, T., Larson, S., Hamerlynck, E. & **Crain, J.** Using genomic selection to develop performance-based restoration plant materials. *Frontiers in Plant Science*.
3. **Crain, J.**, Wang, X., Lucas, M. & Poland, J. Experiences of applying high-throughput phenotyping for wheat breeding and improvement. In *Advanced Concepts and Strategies in Plant Sciences: High-Throughput Crop Phenotyping*. Springer.

Data Sets and Scripts:

1. **Crain, J.**, DeHaan, L, & Poland, J. (2021). Genomic selection enables rapid selection of high-performing genets in an intermediate wheatgrass (*Thinopyrum intermedium*) breeding program. Dryad Digital Repository. <https://doi:10.5061/dryad.zw3r2285n>.
2. **Crain, J.**, Haghghattalab, A., DeHaan, L., & Poland, J. (2021). Development of whole-genome prediction models to increase the rate of genetic gain in intermediate wheatgrass

(*Thinopyrum intermedium*) breeding. Dryad Digital Repository.
<https://doi:10.5061/dryad.73n5tb2t9>.

3. **Crain, J.**, Larson, S., Dorn, K., Kantarski, T., DeHaan, L., & Poland, J. (2020). Sequenced-based paternity analysis to improve breeding and identify self-incompatibility loci in intermediate wheatgrass (*Thinopyrum intermedium*). Dryad Digital Repository.
<https://doi.org/10.5061/dryad.0cfxpnvz3>.
4. **Crain, J.**, Bajgain, P., Anderson, J., Zhang, X., DeHaan, L., & Poland, J. (2020). Enhancing crop domestication through genomic selection, a case study of intermediate wheatgrass. Dryad Digital Repository. <https://doi.org/10.5061/dryad.3j9kd51d9>.
5. **Crain, J.**, Mondal, S., Rutkoski, J., Singh, R., & Poland, J. (2018). Combining high-throughput phenotyping and genomic information to increase prediction and selection accuracy in wheat breeding. Dryad Digital Repository.
<https://doi.org/10.5061/dryad.7F138>.

Book Chapters:

1. Rutkoski, J., **Crain, J.**, Poland, J., & Sorrells, M.E. (2017). Genomic selection for small grains improvement. p. 99–130. In *Genomic Selection for Crop Improvement*. Springer.

Teaching Modules:

1. **Crain, J.** (2018). Genomic Selection, Genome Wide Association Studies, and Quantitative Genetics. Biosciences of eastern and central Africa. Nairobi, Kenya.
<https://github.com/jcrain1/BecA>.

Abstracts:

1. **Crain, J.**, DeHaan, L., & Poland, J. (2020). The Land Institute genomic selection breeding strategy. Kernza Conference Virtual Meeting.
2. **Crain, J.**, Larson, S., DeHaan, L., & Poland, J. (2020). Genome wide association analysis in intermediate wheatgrass. Kernza Conference Virtual Meeting.
3. Turner, K., & **Crain, J.** (2020). Breeding for resistance to *Fusarium* head blight in the new, perennial grain crop intermediate wheatgrass. Plant Health, Denver, CO.
4. **Crain, J.**, DeHaan, L., & Poland, J. (2020). Evaluation of two cycles of genomic selection in an intermediate wheatgrass breeding program. Plant & Animal Genome (PAG) XXVIII, San Diego, CA.
5. **Crain, J.**, DeHaan, L., & Poland, J. (2020). Applied genomics to improve IWG breeding efficiency. Plant & Animal Genome (PAG) XXVIII, San Diego, CA.
6. **Crain, J.**, DeHaan, L., & Poland, J. (2019). Applied genomics to improve breeding efficiency of intermediate wheatgrass (*Thinopyrum intermedium*). New Roots for Agriculture, The Land Institute, Salina, KS.
7. **Crain, J.**, Dorn, K., DeHaan, L., & Poland, J. (2019). Intermediate wheatgrass (*Thinopyrum intermedium*) genomics update. Kernza Conference, Madison, WI.

8. **Crain, J.** (2019). Genomic selection in intermediate wheatgrass (*Thinopyrum intermedium*). Is the Future of Agriculture Perennial. Lund, Sweden.
9. **Crain, J.**, Dorn, K., Kantarski, T., Grimwood, J., Schmutz, J., DeHaan, L., & Poland, J. (2018). Evaluating the effectiveness of genomic selection in an intermediate wheatgrass (*Thinopyrum intermedium*) breeding program. Agronomy Abstracts, ASA Baltimore, MD.
10. **Crain, J.**, Dorn, K., Kantarski, T., Grimwood, J., Schmutz, J., DeHaan, L., & Poland, J. (2018). Genomic selection in intermediate wheatgrass (*Thinopyrum intermedium*). Kernza Conference, Lindsborg, KS.
11. Dorn, K., Kantarski, T., **Crain, J.**, Altendorf, K., Zhang, X., Anderson, J., Wang, S., Larson, S., Plott, C., Jenkins, J., Grimwood, J., Schmutz, J., DeHaan, L., & Poland, J. (2018). Accelerating the domestication and improvement of the perennial grain crop Kernza with genomics. Kernza Conference, Lindsborg, KS.
12. Dorn, K., Kantarski, T., **Crain, J.**, Altendorf, K., Zhang, X., Anderson, J., Wang, S., Larson, S., Plott, C., Jenkins, J., Grimwood, J., Schmutz, J., DeHaan, L., & Poland, J. (2018). Accelerating the domestication and improvement of the perennial grain crop Kernza with genomics. Plant and Animal Genome Conference, San Diego, CA.
13. **Crain, J.**, Dorn, K., Kantarski, T., Grimwood, J., Schmutz, J., DeHaan, L., & Poland, J. (2017). Application of genomic selection to increase the rate of genetic gain of intermediate wheatgrass (*Thinopyrum intermedium*). Agronomy Abstracts, ASA, Tampa, FL.
14. Rahman, M.M., **Crain, J.**, Haghighattalab, A., Barma, N.C.D, Singh, R.P., & Poland, J. (2017). Yield prediction using high-throughput phenotyping in wheat breeding nurseries in Bangladesh. Agronomy Abstracts, ASA. Tampa, FL.
15. Dorn, K., Kantarski, T., **Crain, J.**, Altendorf, K., Zhang, X., Anderson, J., Wang, S., Larson, S., Plott, C., Jenkins, J., Grimwood, J., Schmutz, J., DeHaan, L., & Poland, J. (2017). The genome of perennial grain crop *Thinopyrum intermedium* unravels the evolutionary history of the genus. 8th International Triticeae. Wernigerode, Germany.
16. Haghighattalab, A., **Crain, J.**, Mondal, S., Rutkoski, J., Singh, R., & Poland, J. (2017). Application of geographically weighted regression to improve grain yield prediction from unmanned aerial systems imaging. R.F. Baker Plant Breeding Symposium. Ames, IA.
17. **Crain, J.**, Reynolds, M., & Poland, J. (2016). Efficient utilization of high-throughput phenotyping data. Edgar S. McFadden Symposium. San Antonio, TX.
18. **Crain, J.**, Reynolds, M., & Poland, J. (2013). Application of hand-held proximal sensing tools for field-based high-throughput precision phenotyping. Agronomy Abstracts, ASA. Tampa, FL.
19. **Crain, J.**, Kelly, J., Mullock, J., Ortiz-Monasterio, J., & Raun, W.R. (2011). Evaluation of the new OSU NDVI pocket sensor prototype. Agronomy Abstracts, ASA. San Antonio, TX.
20. **Crain, J.**, Warren, J., & Hattey, J. (2009). Assessment of five soils in western Oklahoma to mitigate rising greenhouse gas concentrations. Agronomy Abstracts, ASA. Pittsburgh, PA.
21. Kelly, J., Edmonds, D., **Crain, J.**, Kanke, Y, Taylor, R., Solie, J., & Raun, W.R. (2009). Refining yield potential algorithms in maize (*Zea mays* L.) based on plant height, competition, NDVI, and stalk diameter. Agronomy Abstracts, ASA, Pittsburgh, PA.

22. Edmonds, D., Kelly, J., **Crain, J.**, Kanke, Y., Taylor, R., Solie, J., & Raun, W.R. (2009). Maize (*Zea mays* L.) grain yield response to by-plant nitrogen fertilization. Agronomy Abstracts, ASA, Pittsburgh, PA.
23. Abreau, S., Godsey, C., Edward, J., **Crain, J.**, & Warren, J. (2009). Soil Organic carbon and total nitrogen under no-till and conventional till in Oklahoma. Agronomy Abstracts, ASA, Pittsburg, PA.