

Increasing Wheat Biodiversity

for Enhanced Productivity, Terroir and Climate Resilience in Organic Systems

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Introduction

Summary

Our goal is to enhance the ecological dynamics within the soil, plant and human systems, by adapting age-old traditions of husbandry and selective seed-saving to evolve resilient community seed systems in the face of unprecedented climate change and globalization.

Introduction

For the past 8,000 farmers have selected landrace seed, generation by generation, developing the wheats that nourished earlier peoples. However recently, genetic management has shifted to the hands of industrial breeders, but with hidden costs. Modern wheat has evolved through a genetic bottleneck of breeding for uniformity and high yield, designed for ease of harvest with goliath combines, dwarfed to not lodge under agrochemicals, and dependent on chemical protectants to survive.



The Harvesters, Breugel 1586



Kansas Wheat Commission, 2009

In contrast, landrace wheats evolved in low-input fields, are genetically diverse, better adapted to organic systems, are the robust survivors of adversity, and have greater adaptability to weather extremes. Emerging research suggests that landrace wheats are more digestible for gluten sensitivities 1.



Emmer



Exchanging landrace seed with Hungarian, Danish and Georgian genebank curators and seed-savers



Einkorn



Forgotten Wheat Species of the Transcaucasus

Methods

Ecological Crop Improvement

Ninety-six populations of landrace winter wheats were procured in Europe and from the USDA genebank. Genepools were screened and selected under organic management in 2008-9. Three plants with desirable traits were crossed to generate composite-cross genepools, and seeds from superior landraces were selected. 15 elite landraces and genepools were planted in the fall of 2009 in 4' x 50' plots x 3 replications, and selected over a three year period. Seeding rates were evaluated. Clover was planted to suppress weeds. Plants were scored for robustness, architecture, lodging, disease resistances, tillers per plant and seeds per tiller, protein and minerals, and more.

Each year seeds from the most robust, intelligent and disease-resistant plants were selected for complex linked traits and replanted. Elite seeds were given to partnering farmers to multiply, select and bulk. We planted mixtures of plants with similar dates to maturity, and spacing trials. Each year new material collected from Europe was screened. A Grain Conference-Festival was held each summer to involve local bakers, educators and community members in exchanging knowledge, skills, breads and seeds.



Landrace Wheat Breeding Trials at the University of Massachusetts

sample #	ID	Wt (g)	mL extraction buffer	Fusarium ug/g seed	Fusarium rating
	Banatka - Cleaned	4.84	33.88	3.19	low
1	Zyta	5	30	4.14	low
2	Rogosa	4.9	34.3	4.46	low
3	Banatka-Eli	5	35	5.74	low
4	Rouge de Bordeaux	5	30	5.58	low
5	Canaan Rouge	5	35	6.38	low
6	Bezbanat	5	35	9.88	low
7	Canaan	5	35	11.64	low
8	Poltavka	5	30	12.75	low
9	Banatka-Tevis	5	35	16.58	low
10	Llamas	5	30	23.43	moderate
11	German	2.31	16.17	30.29	moderate
12	Kavkaz	5	35	34.43	moderate
13	Purple	3.15	22.05	35.55	moderate
14	Purple Barley	5	30	37.30	moderate
15	Melange	4.84	33.88	92.30	high

Fusarium resistance is a key breeding criteria. Tested by agrinostics.com

Variety	Winter Wheat Description	N %
1 Zyta	Zyta, Poland modern	16.06
2 Canaan Rouge	Canaan Rouge, French-Maine landrace	15.43
3 Banatka	Banatka, Hungarian landrace	15.37
4 Rogosa	Rogosa genepool	15.32
5 Bezbanat	Rogosa genepool	15.31
6 Rouge	Rouge de Bordeaux, French landrace	15.12
7 Purple	Ethiopian	15.06
8 Poltavka	Ukrainian Landrace	14.43
9 Purple Barley	Ethiopian	13.56
10 German BD	German Biodynamic	13.12
11 Melange	French Melange "mixture"	12.25
12 German	Davert German modern	11.93

Protein is key baking quality parameter. Tested by A.A. Jaradat USDA

1.Presence of celiac disease epitopes in modern and old hexaploid wheat varieties . etty C. van den Broeck, et al · Theor Appl Genet (2010) 121:1527-1539 DOI 10.1007/s00122-010-1408-4, 2. Abdullah A. Jaradat . Wheat Landraces: Genetic Resources for Sustenance and SustainabilityUSDA-ARS, 803 Iowa Ave., Morris, MN 56267 abdullah.jaradat@ars.usda.gov,

Funded by NESARE

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Discussion

Increasing Genetic Diversity

Increasing genetic diversity of wheat through the use of landrace populations and composite-cross genepools in combination with introgressing traits from modern wheat as appropriate, can be an effective strategy to increase yield in organic fields.

Stable yields under low-input conditions tends to favor the polygenetic traits of landraces over modern pedigree varieties. Genetically diverse populations allow for adaptation through self-regulating, evolutionary systems that echo natural interactions that evolved landrace wheats, providing adaptable traits 2.

Although farmers are the original breeders, this traditional knowledge has been almost forgotten in developed countries. Farmer-to-farmer circles, research and extension support are needed to advance on-farm selective seed-saving and breeding expertise.

Increasing the diversity of wheat can not only improve the livelihoods of farmers and gardeners at the local level, but is a key link for robust local food and farming systems for a planet facing unprecedented climate change and urbanization pressures.



Poltavka, Ukrainian landrace Collected in 1915



Canaan Rouge, selected from Rouge de Bordeaux

Landrace Terroir

Landrace wheats tend to have less gluten toxicity, richer flavor and higher nutrition. As farmers rediscover the power of selective seed-saving, new local organic-adapted landraces can emerge for artisan markets that celebrate 'terroir' - history of the grain, taste-of-the-land, and farmer-in-their-community.

Next Steps

The project is sustaining itself beyond SARE funding through sale of seeds, flour and artisan breads. Lead farmer seed-savers are exchanging locally-adapted landraces. The Heritage Grain Conservancy community seedbank is continuing on-farm seed-saving for evolutionary in-situ conservation of wheat landraces. We welcome cooperation - the work is vast.