



Restoring Ancient Wheat

Nov. 29, 2007



Hosted by the Israel Genebank

in cooperation with

Biodiversity and Environmental Research Center

Jordan Genebank, NCARE

and the

Heritage Wheat Conservancy



Introduction and Welcome

We welcome you to '**Restoring Ancient Wheat**' an action-planning seminar to address a concern shared by genebank curators, seed-savers, farmers, chefs and people that like to eat delicious food, a concern that bridges political boundaries, and that spans the Mideast to encompass global food and farming issues.

*Today at least 85% of the wheat eaten in Israel, Palestine and Jordan
is imported from overseas megafarms.*

*Our delicious indigenous wheats, many of which date back to Biblical times,
are in danger of being lost to the world.*

Modern wheat, the most widely grow crop on the planet, has its ancient homeland in the lands of Jordan-Palestine-Israel. But the ancient wheats that nourished our early civilizations are almost extinct today. Although indigenous wheats have been selected by generations of traditional farmers to be drought-tolerant and resistant to local disease complexes, and have rich, delicious flavor, they are being replaced by modern cultivars bred for yield and uniformity for industrialized food systems. As urbanization increases, and farmers struggle to make a living, the traditional knowledge of seed-saving and community seed systems have broken down. The wheat varieties best suited to our traditional farms, that impart that special flavor to our traditional cuisines, are disappearing.

In a creative response, we are meeting today to pool our knowledge and skills, to build democratic work-teams, and to exchange seed for the common good. Our goals are to:

- share knowledge and skills to conserve landrace seed,
- strengthen community seed systems, celebrate our traditional Mideast & Biblical cuisine, and
- develop markets for native foodcrops for genetic conservation that benefits local communities.

- Elí Rogosa

- Heritage Wheat Conservancy

- growseed.org

SCHEDULE

9:00-11:30 Team Meeting with Genebanks and Conservation Farmers

PUBLIC SEMINAR

12:30 Dr. R. Hadas, ARO - Welcome and Israel Genebank Introduction

12:50 Dr. A. A. Jaradat, USDA - NCSC Research Lab, Morris, MN
Challenges and Strategies to Restore Fragmented
Meta-Populations of Landrace Wheat in the southern Fertile Crescent

13:30 Dr. M. Ali-Shteyah, Dr. M. Shtaya, R. Jamous, Biodiversity Environmental Research Center
Setting Up a Community Seed Bank in the Northern West Bank: Nablus District

14:00 BREAK

14:30 Dr. H. Migdadi, Dr. A. Yassin. N. Rawashdeh, NCARE Jordan
Conservation of Jordan's Landrace Wheat: Challenges and Strategies

15:00 Dr. D. Desclaux and Dr. Y. Chiffolleau, INRA-France
Participatory Plant Breeding: A way to improve and value varietal diversity

15:30 E. Rogosa, Farmer Seed Conservancy
'Restoring Ancient Wheat'
On-Farm Conservation of Landrace Wheat in the Southern Fertile Crescent

15:40: E. Rogosa, Moderator – Display and Discussion of Landrace Wheat Biodiversity
Researchers and Farmers will discuss specific landrace wheat populations,
their traits, history and uses: Emmer, Hourani, Jaljuli, Nursit, and more.

16:15 Light Refreshments with Emmer Bread Tasting baked by Yiftah Barekat



The Israel National Plant Gene Bank

Rivka Hadas

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<http://igb.agri.gov.il>

Israel and its neighboring countries are home for plant genetic resources (PGR) and several crop wild relatives (CWR) of important cultivated plants including cereals, legumes, fruit trees, vegetables, aromatic plants, industrial and pasture species. These are of great interest for future breeding of new cultivated varieties with improved agricultural and economic traits, such as higher yield, resistance to biotic and abiotic stresses, and enhanced levels of valuable nutritional constituents.

The main goal of the Israel National Plant Gene Bank (IGB) is to preserve local PGR in-situ or ex-situ. In the latter, seeds are stored for long periods of time in storage facilities under controlled temperature and humidity. In this way, the genetic variability of wild species and primitive varieties of domesticated crops is conserved for future generations. IGB aims to collect, keep, maintain, and characterize its seed collection; to help in conserving endangered wild species, thereby preserving plant biodiversity; and to support scientific projects that utilize the genetic potential maintained in the bank, allowing the exploitation of the Israeli flora for the benefit of agriculture.

However, the rich biodiversity of southern Fertile Crescent PGR is in danger of extinction because of destruction of natural habitats following intensive urbanization, construction of infrastructure, and rapid transition to modern agricultural practices. One of the most threatened plant groups are the ancient Triticum, landraces that have been grown by the local farmers since the earliest stages of agriculture. These indigenous wheat varieties, many which have not yet been fully collected and characterized, are the target of this project.

It is our hope that the IGB center of biodiversity conservation will become partner in a larger regional network in which gene-banks, researchers, breeders and farmers from all countries will collaborate in studying and preserving the PGR of our area.

Challenges and Strategies to Restore Fragmented Meta-Populations of Landrace Wheat in the southern Fertile Crescent

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Section I - The Genetic Structure of Wheat Landraces and the Challenge to Conserve them on the Farm Indigenous farming communities in the Fertile Crescent (FC) contributed, for millennia, to the evolution, enrichment, and on-farm conservation of wheat landraces (LR). Traditional cultures and cropping systems of the FC shaped present genetic structure and determined the changes within LR populations. Wheat LRs are complex, variable, genetically dynamic and diverse populations, in equilibrium with both environment and pathogens. In the FC, wheat LRs have undergone strong selection pressures throughout their evolutionary history, and developed multilocus structures as a result of selection, genetic drift, or fragmentation of their populations; these structures are retained through selection, isolation, lack of migration, and restrictions on outcrossing and genetic recombination. Little has been done to understand genetic structure of LRs and the interspecific diversity in the subsistence agro-ecosystems they dominate.

The genetic structure of LRs is considered as an evolutionary approach to survival and performance, especially under the arid and semi-arid conditions of the FC. The combined effects of natural and artificial selection have led to an architecture of genotypes representing different combinations of traits such as growth habit, cold, heat or drought tolerance, early growth vigor, time to heading and maturity, and quality traits. The complexity of the population structure of wheat LRs may arise from the number of different homozygotes and the occurrence and frequency of heterozygotes in populations. Characterization of the population structure of LRs is critical to identify and correctly interpret the association between their functional and molecular diversity. Such information is essential to define the areas of adaptation of different LRs, to identify priority areas for on-farm conservation, and to understand the genetic consequences of the interaction between growing environments and farmers' practices.

Two sets of attributes are essential to understand the genetic structure of LRs; these are (1) marker diversity, or the extent of differences between individual copies of a gene, and (2) the variation in adaptation. The first is informative as to the ancestry or breeding history of the populations, and are considered as indicators of bottlenecks in population size, the prevalence of outcrossing, the ease with which genes are recombined, and the level of gene flow between LR populations. The second set comprises indicators of the degree to which populations are adapted to the biotic and abiotic aspects of the environment and of their potential for continued performance or as donors of traits in wheat breeding.

Strategies to Restore Fragmented Meta-Populations of Fertile Crescent Wheat Landraces

Historically, farmers in the Fertile Crescent (FC) planted diverse assemblages of genotypes (i.e., landraces, LRs) to lower the risk of failure and increase food security because they had limited capacity to control the spatially heterogeneous and temporally unpredictable environment of the FC with material inputs. This practice led to the development of LR meta-populations and the emergence of farmers' seed systems through which they accessed and exchanged diverse genetic material. A meta-population structure, defined as a group of subpopulations interconnected by gene-flow and seed exchange among farmers, villages and eco-geographical regions, favors a dynamic evolution of diversity. In the FC, traditional management of wheat LRs contributed more to the conservation of a general level of diversity than to the conservation of genetically stable and distinct populations. Therefore, a wheat LR is far from being a stable, distinct, and uniform unit; its diversity is linked to the diversity of the material sown in its immediate geographical area, and to the level of seed exchange.

The introduction of high-yielding varieties (HYVs) into, and the structural changes in, farming systems of the FC, led to the loss of genetic diversity and fragmentation of meta-population structures of its wheat LRs. These LRs embody not only diverse alleles and genotypes but also evolutionary processes such as gene flow between different populations and local knowledge systems such as folk taxonomies and information about selection for heterogeneous environments. For farmers to continue to grow, select, and manage local LRs, and to reverse the fragmentation of their meta-populations and allow evolutionary processes that mould LR diversity to continue, *the value of these LRs should be raised to approximate or exceed the social value of HYVs.*

Re-creating and structuring local seed systems to simulate a source-sink meta-population model is a first step towards restoring the fragmented meta-population structure of LRs. Such a model should identify the unit of analysis (e.g., the farmer as a decision maker and agent of conservation, the field or parcel representing a particular habitat, the landrace, or a seed lot); incorporate variation among farmers in their practices, knowledge and gender; quantify patterns of seed exchange among farmers and their impact on LR population biology parameters; identify the limiting factors that determine distribution and range of a LR; and define the minimum area needed to create a dynamic equilibrium between “colonization” and “extinction” of a LR meta-population.

The main challenges of on-farm conservation of wheat LRs in the FC are non-biological, but involve a complex of ethno-anthropological processes, involving legal, economic and social factors, superimposed on ecological and genetic processes.

**Setting Up a Community-Based Seed Bank (CSB)
in the Northern West Bank: Nablus District**

M.S. Ali-Shtayeh, R. M. Jamous, M. Y. Shtaya

**Biodiversity and Environmental Research Center, BERC
Til, Nablus, West Bank, <berc.ps>**

A progressive decline in the number of local varieties of food crops mainly cereals and vegetables cultivated in the Palestinian area has taken place over the last three decades. This trend has been partially attributed to rapid changes brought about in agricultural technology resulting in genetic erosion and disappearance of eco-geographically adapted crop cultivars and simultaneously putting at risk farmers' knowledge of seed selection, treatment and storage. It has thus become obvious that community seedbanks (CSB) interventions must be made to enable Palestinian farmers, to access seeds, conserve, document and enhance their resources and knowledge. The CSB intervention can be integrated with the traditional community farming systems in semi-arid agriculture in the Palestinian area. BERC therefore has established a CSB in the northern area of the West Bank as a complementary component of the BERC-Til Botanic Gardens, to function as a facility and the center for seed requirements of farmers in the project's area, to enhance and keep alive the tradition of nurturing diversity through such aspects as: access to seed of farmers' choice; farmers' capacity building in producing desired seed of specific crop cultivars; providing strategic seed reserve in drought years; production of good quality seed; ensuring farmers' seed security at household level. The established CSB, which is an improvement over the old concept of a seed bank being a mere storage or retrieval mechanism and structure, also functions as a facility for on-farm germplasm conservation through utilization; farmer training in the modalities and rudiments of seed production; seed selection, treatment and storage; and exchange of germplasm, information, innovations and technologies between and among farmers, extension agents and researchers. Target plants are mainly food crops including cereals, legumes and vegetables. The new agricultural biodiversity of seed has allowed the diversification of crops that can easily adapt to climate, soils, and rainfall patterns. Also knowledge information is exchanged about the traits and characterization of new varieties. The overall goal of the CSB establishment is therefore, twofold: one, to maintain and improve local crop accessions that will ensure lasting food productivity and availability, as well as increase source of income in the target local communities, and two, to enhance the diversities of traditional food crop varieties.

Conservation of Jordan's Landraces Wheat: Challenges and Strategies

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Thousands of years ago, the people of Fertile Crescent (FC) realized the importance of Wheat Landraces (LR's). Wheat landrace became the important source for food. To this day, traditional farmers have been the custodians of this important germplasm, in spite of recent release of high yielding improved cultivars since the green revolution. Modern-bred cultivars are successful in high-input environments, but are unable to boost yield in the low input environments of most of Jordan's farmers.

Despite the fact that modern breeders utilize a scientific approach in breeding new varieties, the approach has shown to be limited. They have neglected, for the most part, the importance of LR. Although, LR's can be considered as the back bone for most crops, they do not compete with modern varieties in yield production. They have other important traits. Recently, both farmers and breeders have documented the capacity of LR to buffer stresses, such a climate extremes and drought, and their genetically diverse heterogenous populations. However, modern breeders are more concerned in releasing a widely-adapted variety that reflects geographical concept rather than genetic concept.

Thus, the farmers in Jordan's dry and semi-dry conditions urge breeders to adopt innovative strategies in cooperation with gene banks to launch Participatory Plant Breeding (PPB) initiatives. The power of PPB to enhance the current scientific paradigm addresses multiple levels: enhanced scientific research, farmer and community participation and institutional cooperation. PPB emphasizes working in partnership with farmers to enhance LR parameters, ie: flavor, color, and efficient water-use properties. Economic interests urge gene banks and breeders to collect new wheat accessions in the southern Fertile Crescent. We must protect the role and rights of traditional farmers to conserve and benefit from the landraces that they have maintained. The International Treaty On Plant Genetic Resources For Food And Agriculture affirms the equal involvement of farmers in decision-making at national and international levels.

'Restoring Ancient Wheat' is a program to foster cooperation of gene banks, traditional farmers and market initiatives that benefit local communities. Let us restore the seed (and the benefits arising from the seed) back into the hands of the farmers by a new model of ethical participatory plant breeding and market development- by farmers and gene banks working together to produce uniform database that can lay the foundation of a regional network for the conservation of our wheat LR'S in the Fertile Crescent.

Participatory Plant Breeding: A way to improve and value varietal diversity

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The standardization of cropping systems and the induced homogenization of agricultural environments (E), encouraged by the productivist model, have resulted in the homogenization of genotypes (G) and therefore a decrease in varietal diversity (between and within), and a drastic reduction of GxE interactions.

Currently, European agriculture is evolving towards a great diversification of approaches not only from an agro-ecological point of view (analytical vs. systemic approaches) but also from a socio economical perspective (individual logics vs. collective governance). To fit the large range of targeted environments, specific expectations in matter of genotypes (from inherited genetic resources to varieties representing genetic, ethical and social progress) and several breeding objectives (from yield improvement to farmers' empowerment) are emerging and thus are changing the way plant improvement is envisaged.

Depending on the approach, the order, interest and status of the five classic stages of plant improvement (setting objectives, creating variability, selecting, evaluating and disseminating) may be called into question. Between the existing factorial model and a holistic model that remains to be developed, lies the challenge of ensuring the sustainability, improvement and valuation of varietal diversity.

On the base of a project aiming to create varieties adapted to organic conditions currently implemented in south of France, we propose to analyze the change in the way of thinking about GxE interactions, in order to better manage varietal selection and enhance both varietal diversity and markets diversification. Considered by plant breeders as a 'major obstacle to progress in genetics', we will discuss how GxE may become (i) for the consumer a source of a specific quality linked to a specific 'terroir', (ii) for the farmer, a way of breaking with standardization of crop management and of markets; and (iii) for the citizen, an issue of identity and policy.

From a simple 'noticing' that we attempt to reduce, the GxE interaction has become an 'objective' that we try to predict and valorize. Structuring the different components of E, G and GxE, enables us to extend the basic concept of "representativeness" to take in account both cultivation conditions and socio-economic « positions » of all the actors concerned by varietal diversification and valuation.

Restoring Ancient Wheat On-Farm Conservation of Landrace Wheat in the Southern Fertile Crescent

Eli Rogosa

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Landrace seed is the living embodiment of a plant population's evolutionary and adaptive history, an ark of traits born across generations into our hands. It is the expression of species interaction of the plant in its environment and the human culture that shapes it. The southern arch of the Fertile Crescent is the center of biodiversity for wild and ancient landrace wheats. Our landraces evolved over millennia of natural and farmer selection to thrive in local conditions and carry wide genetic diversity. However, recently genetic management has shifted into the hands of industry breeders - but with hidden costs.

Modern wheat, the most widely cultivated crop on earth, is bred by industrial breeders for uniformity and high yield in favorable environments with little regard to the needs of traditional and organic farmers with low-input field condition, or markets that value taste, nutrition and local cuisine. Important characteristics, such as extensive root systems for nutrient scavenging, nitrogen-use efficiency, and durable horizontal resistances to local disease complexes tend to be minimized in modern wheats.

In traditional farming systems where landrace wheats evolved, women contribute much of the work, select seed for planting, process grains and prepare the food. Research tends to focus on bio-physical factors, ignoring key social dimensions that inform the plants' total evolutionary system. Selecting crops for yield and agronomic traits alone excludes criteria that produce foodcrops for culturally diverse cuisines. Just as wild crop relatives are genetic resources that cannot be contained in *ex situ* facilities, ecological relationships such as gene flows between populations, natural selection/adaptation to the environment, and social impacts are components of a crop's total evolutionary system.

Today's unprecedented erosion of landrace biodiversity has resulted in dependence on fewer varieties and fragmentation of remaining population, limiting food security, nutrition and culinary arts. Due to replacement by modern cultivars and loss of community seed systems, the very landrace wheats that sustained our ancient civilizations (and the traditional farmers that steward them) are threatened – *many on the verge of extinction*. Conserving and restoring the agro-biodiversity of landrace wheat is not only is the best defense against disease, pest and environmental stress, but can enhance the livelihoods of low-input and organic farmers world-wide - a key link for robust community seed and food systems for a planet facing unprecedented climate change, population growth and urbanization pressures.