On-Farm Conservation of Agrobiodiversity in Israel  
Challenges and Case Study: Restoring Ancient Wheat

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Key Words: agrobiodiversity, landrace, seed, in-situ conservation,

Abstract

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 land of Israel, in the southern arch of the Fertile Crescent, is a center of biodiversity for important world grain, fruit and vegetables that include: almonds, artichoke, arugula, barley, beet/chard, celery, chickpea, date, emmer, fig, flax, lentil, lettuce, melon, mustard, olive, pea, radish, and wheat. Our landraces have evolved over millennia of natural and farmer selection to be well adapted to local conditions and carry wide genetic diversity. However, recently genetic management has shifted to the hands of industry breeders - but with hidden costs.

‘Israel's commercial agriculture is totally reliant on modern high-yielding hybrids. This, urbanization and habitat erosion threaten the indigenous landraces, some of which date back many centuries, if not to Biblical times.’ Israel Genebank, 1996

After millennia of displacement from the land of Israel, most farmers jumped into the green revolution to feed a growing population with seeds of modern breeding. However, the high yielding cultivars bred for uniformity and shelf life for global markets do not meet the needs of low-input farmers and gardeners with limited inputs. Today in Israel there are no commercially available indigenous wheat or open-pollinated vegetable seed - except what farmers and gardeners domesticate, select, save and exchange amongst ourselves and our neighbors or import.

‘In the West Bank there is considerable decline in local varieties due to introduction of modern hybrids. Over 80% of Palestine's farmers have no irrigation. Both the drought-hardy traditional cultivars and farmers' traditional knowledge of seed selection are disappearing. There is a critical need to revive traditional varieties, however the PA has no central seed bank. Existing facilities are weak or non-existent.' Dr. Shtayeh <berc.ps>

Traditional farmers struggle to make a living and local seed systems have become fragmented. Rural communities that were self-sufficient have lost their livelihoods due to low-cost imported foods and lack of competitive rainfed varieties. The unprecedented rate of erosion of landrace varietal diversity results in dependence on fewer varieties and genetic depression of remaining landrace populations, limiting food security, nutrition and culinary arts. Due to replacement by modern cultivars and loss of community food systems, the very landrace wheats and vegetables that evolved valuable locally-adapted traits and the farmers and gardeners that steward them are threatened – many on the verge of extinction.
A. On-Farm Conservation

Seed-saving and adaptive selection has been the right and responsibility of farmers since the emergence of agriculture. The goal of on-farm conservation is to support farmers to continue to conserve and evolve landrace crops, especially important in the context of today’s increasingly globalized seed system. Maintenance of landraces is best accomplished in the typical conditions of the traditional fields where the crops evolved. On-farm genetic resources encompass not only alleles, genotypes, phenotypic, agronomic and weather conditions, pathogen and pest complexes - but includes the agroecological and social relationships for a dynamic evolution of the landrace crops. Unlike ex-situ conservation that addresses more easily quantified genotypes, on-farm conservation encompasses indigenous knowledge, cultural practices, cuisine and markets. Just as wild crops are genetic resources that cannot be maintained in ex-situ facilities, gene flows between populations, adaptation to the environment, farmer selection and cuisine are part of a landrace’s dynamic total evolutionary system.

Israel Seed Conservancy

In response to our region’s critical loss of agrobiodiversity, a farmer-led Seed Conservancy has come together to conserve our threatened indigenous varieties and return seed back to the hands of farmers and gardeners.. The Seed Conservancy has conducted five seed-saving training-conferences with seed exchanges reaching hundreds of home food gardeners, coordinates a ‘seed library’ to re-introduce superior locally-adapted, open-pollinated heirloom varieties stored in inaccessible genebanks, and is establishing an in-situ conservation farm in cooperation with the Israel Genebank, Palestinian Seedbank <berc.ps> and Jordan Genebank <ncartt.gov.jo>. We work with three synergistic projects:

1. **Bustan: Traditional farming and seed systems,**
2. **Bread: Indigenous knowledge and culinary arts**
3. **Alumot: Restoring ancient wheat**

1. Mideast Traditional Farming Systems

The myth and metaphor of the garden as a sacred space echoes in both the Hebraic and Islamic heritage, and is reflected in the Mideastern ‘bustan’, or integrated homestead, that traditionally combines wheat and barley fields, stone walls with unplowed wild habitats at each side, fruit trees embracing semi-shaded vegetable plots, an outdoor clay oven, and outdoor sitting area with cooling grapevines garlanding the home. ‘Seder Zariim ’ (The Way of Seed) of the Mishnah/Talmud, written in the 2nd – 5th century documents ancient Israeli farming and food traditions in detail. The bustan is still found in rural villages, but has little place in modern Israel’s urban planning. Israel’s recent 100,000 Ethiopian-Jewish immigrants bring vast indigenous seed-saving knowledge of diverse varieties from the Ethiopian center of biodiversity. Most were traditional farmers but today have joined the ranks of Israel’s low-income, under-employed landless urban populations. Few have found ways to adapt their age-old farming methods to compete with the dominant agri-tech farming. So they resort to shipping their ancient Ethiopia wheat, teff and other traditional foods direct from Ethiopia to family-run markets. The ‘bustan’ model today inspires Israel’s burgeoning ecological farming movement, who are reaching out to traditional farmers and to pioneer urban farms.
2. Indigenous Knowledge: Women Farmer-Seed-Savers

*How can we continue to ignore women if they are at least half the farmers?* M. Fernandez CGIAR

Conventional genetic research tends to focus on bio-physical factors, ignoring the crucial aspects of the social dimensions that inform the plants’ total evolutionary system. In the traditional farming systems where landrace crops evolved, women contribute much of the work, select seed for planting, and prepare the food. Yet the gender-specific role and knowledge of women is almost invisible in formal research on in-situ conservation and breeding initiatives.

Landrace varieties are an integral part of traditional food cultures. Culinary uses of landrace wheats by traditional peoples world-wide are based in the unique characteristics, flavors, textures and colors of heritage varieties. Selecting crops for yield and agronomic traits alone excludes essential aspects of producing food crops for nourishing, culturally diverse cuisines.

3. Case Study: Restoring Ancient Wheat

The Seed Conservancy is working with landrace wheat as a key strategy to increase agrobiodiversity and livelihood security. Why? In Jordan, Israel and Palestine, at least 85% of our wheat is imported from US mega-farms. Our landraces are being replaced with industry-bred wheats that do not produce well in low-input and organic systems with limited water. Traditional farmers have not sustained benefit from 'green revolution' high yield varieties requiring expensive inputs. Conserving and breeding wheats for resource-poor and organic farmers in the drought-prone Fertile Crescent is a critical unmet need.

Israel’s ancient wheats have a rich full taste with a depth of complex flavors that makes modern bread, even modern artisan baked bread, insipid by comparison. Why? Israel’s native durum wheats are the one of the oldest strain of wheat to be domesticated, and are infused with traits from wild emmer.

Wild emmer wheat, (T. dicoccoides), called ‘Em Ha’Hitah’ meaning *Mother Wheat* in Hebrew, grows on the wind-swept hills of the Galilee to the mountains crowning Jerusalem, and up to the plateau of the Golan Heights and Houran plains. Over millenia of domestication, wheat has slowly lost wild emmer’s capacity to accumulate protein, micronutrients, zinc and iron in its grain. The survival mechanism of accumulating nutrients in the grain enables wild emmer to germinate in uncultivated soil. Wild emmer’s complex nutrients in its grain translates directly into extrodinarily rich flavor. From ancient days to today, wild emmer surrounds our indigenous wheat field edges, quietly providing a dynamic geneflow of flavor-rich traits. The genetically diverse landrace populations allow for adaptation through self-regulating, evolutionary systems that echo the natural interactions that evolved landrace wheat adaptable traits. This long-term dynamic selection process ensures the yield stability over years of typical Fertile Crescent weather.
The successful introduction and long-term sustainability of on-farm conservation depends on direct benefits that increase livelihood security for men and women farmers. Qualities such as a flavor and baking traits, unlike yield and disease resistance, are not directly influenced by natural selection. Maintaining and enhancing quality characteristics in a landrace population is important for value-added organic markets. A population-based breeding using recurrent mass selection, combined with introgressing improved traits, may be effective to increase yield and quality under participatory breeding systems. Genetic management to improve the yield and quality of low-water-demand cultivars is an untapped solution for livelihood and food security.

Biodiversity is the farmer’s best security against disease, fluctuating markets and climate changes. Conserving and increasing the diversity of landrace foodcrops is not only the best defense against disease, pest and environmental stress, but can improve the livelihoods of low-input/organic farmers and gardeners at the local level, and is a key link for robust local food and farming systems for a planet facing unprecedented climate change and urbanization pressures.

‘If the farmers thrive, the landraces will thrive’ Kostas Koutas <aegilops.gr>

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