

Electron microscopy photography shows the minute wonder of seeds. Inherently immobile, plants have developed a myriad of strategies to disperse their seeds to broaden their evolutionary potential.

*Delphinium peregrinum*  
(Ranunculaceae)  
Larkspur seed.  
Image from *Seeds—Time Capsules of Life* by Rob Kessler and Wolfgang Stuppy, published by Papadakis copyright 2014



## Seeds are Life

**A single tiny seed is not only the foundation of our food, clothing and medicine. It is a living time capsule that represents the rich heritage of our biological diversity and cultural knowledge.**

Seed-bearing, flowering plants evolved 300 million years ago and, through gradual adaptation and spontaneous mutations, today carry complex genetic information that is fine-tuned to adapt to specific locations and support dynamic ecosystems.



Most flowering plants have large genomes, which means they are less able to adapt to extreme habitat changes and are at greater risk of extinction. *Paris japonica* (Liliaceae) Japanese canopy plant, has the largest known genome recorded, more than 50x the size of the human genome.

Over thousands of years our ancestors have assisted this natural selection by selectively breeding the seeds of plants with resilient and beneficial traits, creating populations of plants with rich and historically versatile gene pools known as **“heirlooms.”**

These locally cultivated seeds of the past are invaluable for their adaptive traits in a plant world increasingly challenged by climate change, habitat loss and constantly evolving diseases. These seeds are also critical to biodiversity.

## Seeds are the Foundation of Biodiversity

**Biodiversity describes the diversity of species and their rich interactions. All species require genetic diversity *within* their populations to thrive. Genetic breadth and depth are essential to earth’s balanced, self-sustaining web of life.**

Diverse gene pools are integral to environmental stability as well as our future food supply, which is increasingly dependent on a small group of crops for maximum output and application, to the exclusion of local varieties. When we lose a seed, we lose a food. We also lose a gene that could fight off future diseases and other calamities with negative effects on sustainability and human health.



Heirloom Carrots

Photo credit: USDA

The loss of the planet’s biodiversity—as evidenced in today’s rapid decline in genetic seed diversity—is such a major concern that **the United Nations has declared 2011-2020 the Decade on Biodiversity.**

# A Moment in Time

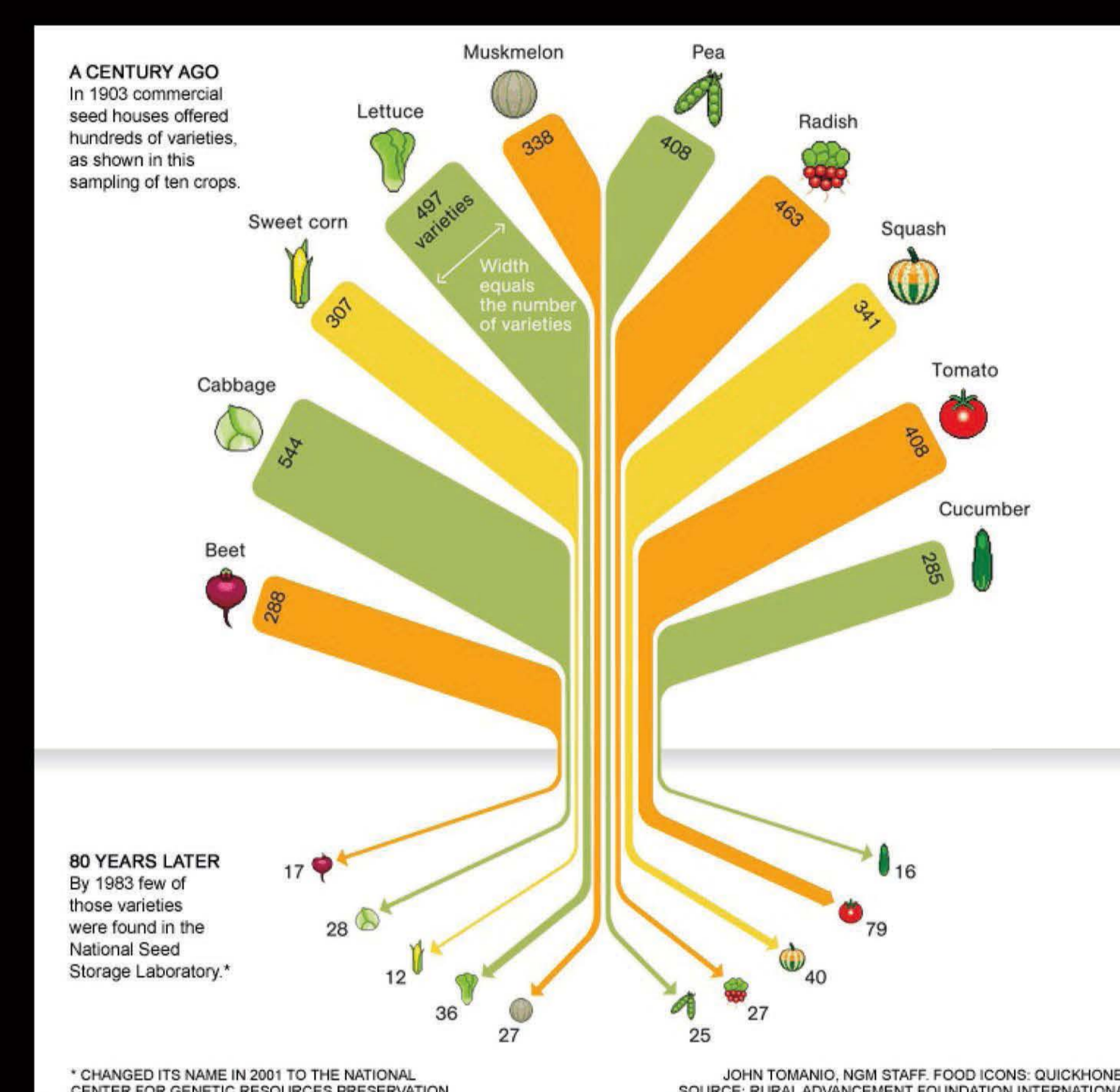
*"Wisdom Begins with*

## Seed Diversity A Modern Dilemma The Perils of "One Size Fits All"

Over the last century, habitat destruction, pollution and climate change have outpaced the ability of many species to adapt and thrive. At the same time, rapid population growth demanded volume and efficiency in food production and distribution.

This dilemma of dwindling supply and growing demand caused farmers to move away from the multiple varieties of locally grown crops toward higher yielding, more genetically uniform varieties.

The practice of growing the same genetically similar crop year after year without rotation is called "monoculture." The mass planting of these single crops disrupts a healthy, self-sustaining ecosystem's ability to adapt through dynamic rebalancing of soil microbes. A homogenous genetic pool is at risk of collapse when confronted with unforeseen crises such as an epidemic.



When we lose a seed, we lose a food.






Photo credit: Seed Map/ USC Canada

### The Irish Potato Famine: A Monoculture Disaster

Beginning 7,000 years ago, Andes farmers cultivated the indigenous potato and created more than 4,000 varieties, selected for traits of disease resistance and climatic tolerance. In contrast, Irish farmers during the Great Potato Famine took part in the pervasive planting of a single species, the blight susceptible "lumper" potato, which led to widespread crop destruction by the pathogen *Phytophthora infestans*.



### In the US, in particular, since the 1950's:

-  Large scale, intensive farming after WWII drove out small farms and favored single-crop produce that relied on hybrid seeds over heirloom seeds to guarantee uniformity.
-  Small seed companies were acquired and merged under a handful of larger companies. Consolidation of the seed industry shifted ownership toward large corporate multinationals and away from public breeding programs and seed saving farmers. Only about 100 independent seed companies remain in the US today.
-  In the quest for better yields, scientists experimented with genetically modified seeds ("GMs") - grown as monocultures or crops with limited rotation—that now account for well over 50% of US food crops.

Typical squash varieties of today vs. the diversity of the squash and gourd tower at the National Heirloom Exposition, Santa Rosa, CA



# - Seeds of Survival

*Wonder” - Socrates*

## Seed Choices



## How they Affect Diversity

### Big Differences in Tiny Packages



*Seeds of heirloom Amazing Glass Gem Corn from Seeds Mania interspersed with Baker Creek Heirloom Seeds corn seeds*

**Heirloom or “saved” seeds** are open-pollinated (“OP”) by insects, birds, wind, water or other natural means.

Grow unique plants with subtle differences in flavor, color, shape and immunity. Typically accompanied by extended harvests and high nutrition.

Consistently bred for 50+ years, creating generally stable lineage. Saved and shared generationally and within communities.

Genetically attuned to the ecosystem; prime candidates for organic farming methods.

**Hybrid seeds** are crossbred from two different plant species in a carefully controlled manner to create a novel offspring.

Grow a “one size fits all” plant with selected taste and yield characteristics, uniform size and narrow harvest time.

Will not reproduce consistently in the next generation. Must be repurchased from proprietary commercial seed companies.

May require chemical additives due to limited immunity. May also be grown organically.

**Genetically Modified seeds** are created using high-tech gene splicing, crossing biological kingdoms, such as bacteria and plants. Genes from non-plant organisms also can be used.

Grow identical plants modified for specific attributes, including pest resistance, and herbicide or drought tolerance.

Protected by technology that renders seeds sterile or by patents, prohibiting collection and cross-pollination and requiring annual repurchasing.

Often require significant chemical and herbicide inputs; cannot be labeled organic.

## The GM Impact on Heirlooms

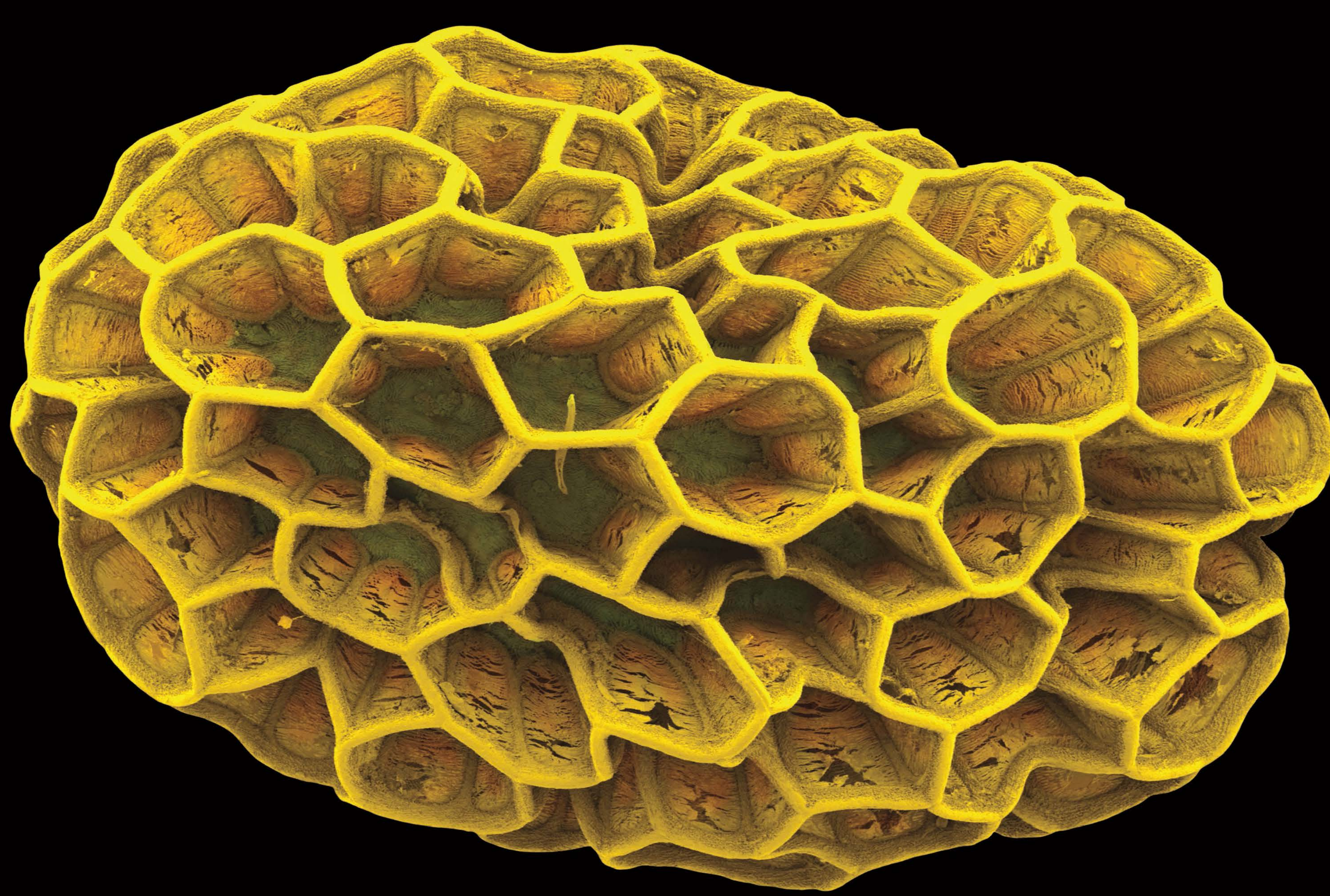


**By UNFAO estimates, we must grow 70% more food by 2050 to keep up with population growth.** Some GM crops may produce higher yields, withstand temperature/salinity fluctuations, and/or tolerate certain diseases, pests and herbicides, but the benefits come at a cost. *Some examples:*

**Contamination:** Wind-born pollen and bird droppings are two ways patented GM crops can threaten the genetic integrity (and certification) of organically grown crops. GM pollen also disrupts the habitats of pollinators, such as the Monarch butterfly and bees.

**Soil balance:** The use of crops engineered to produce their own insecticide, and such herbicide use as *glyphosate* on herbicide-tolerant GM crops, threatens the healthy soil balance required by organic plants. The effects of toxins persist in the soil a long time, impacting plants in subsequent growing seasons.

**Intellectual property Rights:** Once patented GM seeds cross into heirloom fields, those neighboring farmers face legal liabilities, making organic heirlooms less attractive to grow. Patented seeds also conflict with farmers’ traditional techniques of seed saving and breeding to adjust to climate or consumer demands.



These colored electron microscopy photos show the uniqueness of their seed subjects. The propensity for individuality is in humanity and all of nature. Variety is much more than the spice of life—it is the essence of natural systems.

*Loasa chilensis* (Loasaceae) Balloon seed. Image from *Seeds—Time Capsules of Life* by Rob Kessler and Wolfgang Stuppy, published by Papadakis copyright 2014



## Why Heirlooms Matter

“Heirloom” describes a family treasure “passed from one generation to another.” Saved for their taste, texture, tolerance and other traits important to farmers and gardeners, these genetically diverse seeds are resilient and adaptable to local conditions.

**The planet’s environmental stability and food supply depends on plants that can adapt to change.** Yet a systemic global crisis threatens the survival of heirlooms and healthy ecosystems. In the US, some 90% of our fruit and vegetable varieties have already disappeared. **Propagating and saving heirloom seeds is our opportunity to preserve biological diversity and our rich plant and cultural heritage.**



## What is Being Done

As plant species are threatened with extinction, a variety of institutions have developed strategies to protect and preserve seeds.



**Seed Banks, Seed Libraries and Exchanges** The mission of seed banks is to preserve genetic variation within and between

individual plant species against incremental and catastrophic loss. Seed libraries and exchanges also preserve agricultural biodiversity but focus on distributing seeds, especially local and heirloom varieties, to the public. Some examples are shown at right.



### Svalbard Global Seed Vault

(Norway) Built into the permafrost of a sandstone mountain 800 miles from the North Pole, this “doomsday vault” stores duplicates of seeds from more than 1,400 gene banks worldwide. (pictured on left)

### National Center for Genetic Resources Preservation

(US) A USDA facility that stores “a national collection of genetic resources to secure the biological diversity that underpins a sustainable US agricultural

### Kew Millennium Seed Bank Partnership

(UK) Dedicated to saving wild plants faced with the threat of extinction, the project also funds seed banks in a global network of 80 countries. Latest saved seed count: 34,088 wild plant species.

### Seed Savers Exchange

(US) An 890-acre Iowa farm with 13,000 members dedicated to saving and sharing heirloom varieties—“America’s culturally diverse but endangered garden and food crop heritage.”



## What You Can Do

“Don’t judge each day by the harvest you reap but by the seeds you sow”  
~ Robert Louis Stevenson

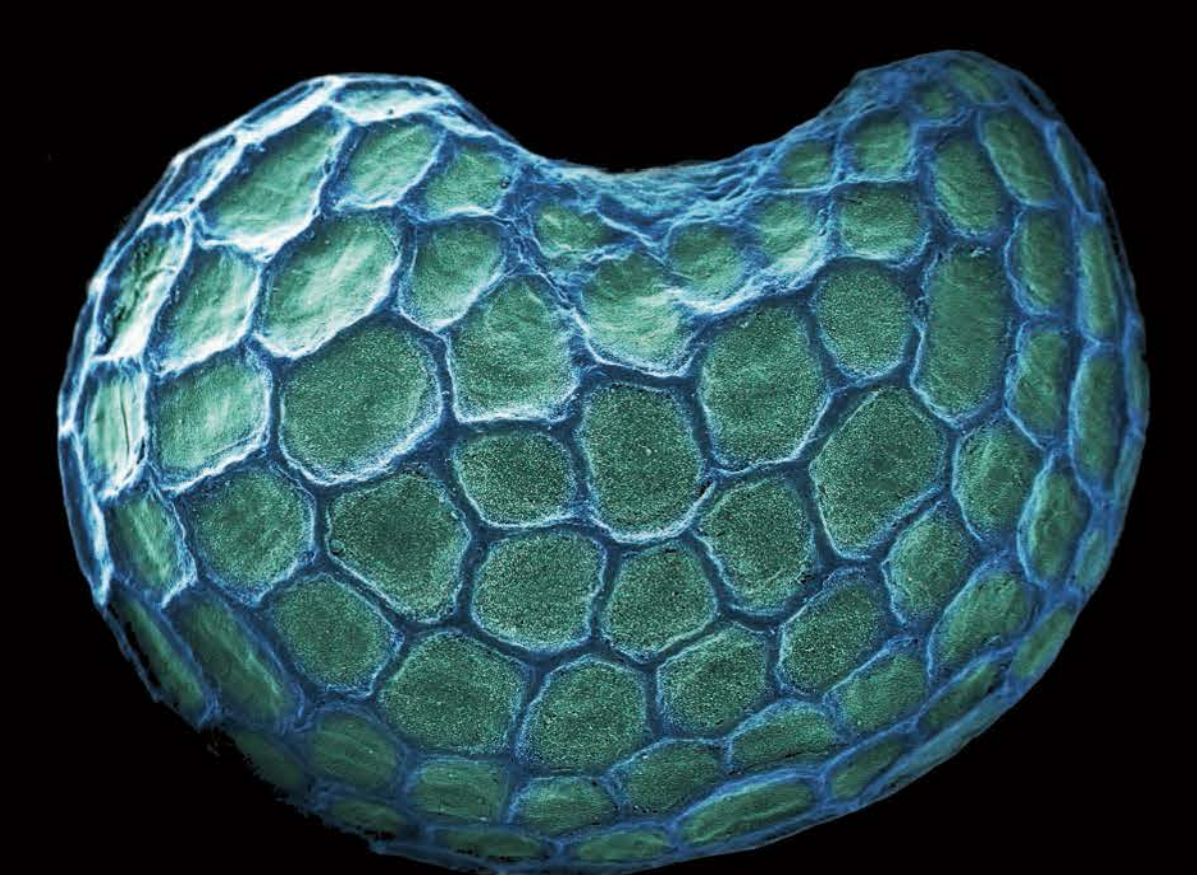
**Grow heirloom seeds.** Help pass heirlooms on to the next generation.

**Buy local and organic produce.** Support farmers’ markets and small farms.

**Support GM-labeling initiatives.** Required in more than 64 countries, GM labeling is not mandatory in the US.

**Support limits on patent litigation** Keep seed development and distribution in the public sector.

**Support local heirloom seed exchanges and libraries.** Groups such as the Hudson Valley Seed Library welcome seeds from local gardens. This continual exchange, “from hand to hand, person to person, garden to seed farm, keeps varieties dynamic – changing with the ever changing conditions of the climate, disease pressures, and human desires.”



Scanning electron microscope photo of *Papaver* (papveraceae) poppy seed by Kelly Wagner San Joaquin Delta College 2011

