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Evaluating perennial candidates for domestication: lessons from wild sunflower relatives

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Abstract

Recurrent selection for increased seed production has been successful in two wild perennial species related to sunflower, *Helianthus maximiliani* and *Silphium integrifolium*. A third species, *Helianthus pauciflorus* has highly heritable variation for seed yield and should respond to selection. Each wild species has a different set of traits that limit its usefulness as a grain crop and each has unique adaptations beyond the perennial habit that could enhance its value or accelerate its domestication. For example, *S. integrifolium* is deeply rooted and relatively unaffected by short term droughts, while *H. pauciflorus* is easily asexually propagated by tubers making clonal cultivars feasible.

More generally, we ask which traits make a wild perennial more genetically and agronomically tractable and which complex but ecologically important traits might only be brought to the agroecosystem through domestication? Any perennial grain reduces the need for tillage, but perennials are not equally drought tolerant, competitive with weeds or carbon sequestering. We suggest, from both experience and deduction, that seed yield and the classic domestication traits such as shattering may often be less important in selecting perennial species for domestication than genetically complex traits such as growth rate, phenology or branching pattern.

While the annual habit is associated with reduced resource acquisition and conservation, it is also provides a convenient method for controlling the timing and synchrony of flowering, shoot meristem density, extraction of soil moisture (e.g., through fallow seasons), and--combined with tillage--soil living animal (e.g., gopher) and perennial weed populations. Rapid population cycling, especially combined with self-pollination may effectively purge genetic load and definitely facilitates breeding progress. We need to think about how perennial cropping systems can perform these functions and whether they are best achieved by careful selection of perennial species with particular traits, plant breeding, gene discovery or new agronomic equipment and practices.