

Title: Tree Crop Domestication

As concerns mount about a changing climate, a growing population, and impacts of modern agriculture, interest in sustainable agriculture has focused attention on perennial crops, which offer promising options for food production while decreasing environmental impacts. However, comparatively little is known about perennial crop domestication in comparison with the extensive research on annual plant domestication. Here, we review the hallmarks of tree domestication, including morphological evolution, domestication bottlenecks, geographic origins, and crop-wild gene flow, highlighting similarities and differences with annual crop domestication. We then explore these topics in detail using two tree crop case studies: pecan (*Carya illinoensis*) and apple (*Malus x domestica*). Pecan (*Carya illinoensis*), a native North American species and a recent domesticate, is prized for its oil-rich, nutritious nuts. Comparative analyses of native and cultivated individuals demonstrate little reduction in genetic variation associated with the domestication process, the result of relatively few generations of selection and diverse geographic origins of selected individuals. Further, we co-opt a breeding collection of living pecan trees to examine genetic and environmental influences on phenological traits. Using domesticated apple (*Malus x domestica*) as a study system, we look in detail at the genetic bottlenecks associated with crop improvement in domesticated perennial fruits compared to annual crops. Much as is the case with the initial domestication bottleneck, the reduction in genetic variation appears to be mild, although there are exceptions to this trend. In addition, we apply a variety of population assignment and admixture detection analysis methods to demonstrate the presence of crop-wild gene flow between domesticated apple and its wild relatives.