High dimensional phenomics and automation to transform domestication of new crops

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The majority of domesticated plant species are herbaceous annuals and woody perennials, yet many herbaceous perennial species hold potential for future agricultural systems. In addition to multiyear harvests, herbaceous perennials provide many ecosystem services, including erosion control as a result of their large and persistent root systems. However, the multiyear lifespan of perennial species has been a barrier to rapid domestication as breeding cycles require phenotyping over multiple growing seasons. Using phenomic selection, high-dimensional secondary traits measured on seedlings could be used to develop relationship matrices among individuals which are then used to predict field traits. Additionally, these models can serve as the selection criteria to identify individuals to advance to the next (pre)breeding generation, thus shortening the breeding cycle. This project substitutes costly genomics data with high-dimensional phenomics data asking: Can elite individuals of perennial species be predicted by phenomic relatedness models based on high- dimensional traits recorded on seedlings? To date, we have imaged 2280 seedlings from each of the following three perennial crop candidate species: intermediate wheatgrass (*Thinopyrum intermedium)*, sainfoin (*Onobrychis viciifolia)*, and silphium (*Silphium integrifolium)* on the Bellwether Foundation Phenotyping Facility housed at the Danforth Center. The images were processed using PlantCV to generate high-dimensional color and near-infrared profiles for each plant on each image day. Additionally, profiles were generated with handheld spectrometers. This work re-imagines innovations in plant traits, kinship matrices, genomic selection, phenotyping centers, and ultimately domestication, in order to expedite the development of an emerging generation of climate resilient, ecologically sustainable crops.