Potential Gain from Selection in Heirloom Dry Beans (*Phaseolus vulgaris* L.)

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**Abstract:** As part of a larger effort to breed dry beans (*Phaseolus vulgaris*) for organic systems, we are evaluating within-line variability and selecting superior lines from within fourteen, genetically diverse heirloom populations. Our evaluations this growing season focused on morphological characteristics (e.g. days to flowering, canopy height, seed yield/plant, etc.). Initial data indicate that heirloom dry beans maintain significant variability in morphological traits, which suggests an opportunity to make significant gains from selection.

**Background:** The common dry bean (*Phaseolus vulgaris* L.) is a staple pulse crop around the world, grown extensively in tropical climates for its nutritive qualities (Gowda et. al., 2009; FAO Statistics, 2011). The U.S. Midwest is a major dry bean-producing region, comprising nearly fifty percent of national production (USDA ERS, 2011). Initial market research indicates that there is interest from small producers and retailers for local, organic dry beans (Regional Sustainable Development Partnerships, unpublished data). In particular, there is an expressed demand for heirloom varieties.

Heirloom dry beans, also known as landrace or heritage types, are loosely defined as “old varieties still maintained by gardeners or famers, particularly in isolated or ethnic communities” (Whealy, 1990; Camacho Villa, 2006). Heirloom dry bean cultivars are assumed to be heterogenous mixtures of homozygous plants (Rodino et. al., 2009), which suggests that there is room for crop improvement. The pedigree and selection history of these cultivars, however, is often absent or anecdotal. In order to better understand their population structures and evaluate the potential of heirloom cultivars in breeding programs, levels of variation within these cultivars must first be established.

**Research Hypotheses and Objectives:** We hypothesize that heirloom dry bean cultivars exhibit satisfactory yield performance to warrant their production in local systems. It is also our hypothesis that heirloom dry bean cultivars exhibit adequate levels of genetic variation to allow for the selection and evaluation within cultivars. In order to explore these research hypotheses, three distinct research objectives were developed:

1. Evaluate yield performance and stability of heirloom cultivars.
2. Estimate phenotypic variation in heirloom cultivars.
3. Select superior lines within heirloom cultivars.

**Experimental Design:** To evaluate the yield performance of heirloom cultivars, twenty-two dry bean varieties (three checks and nineteen heirloom cultivars) were tested in yield trials during summer 2013. Plots were arranged in a randomized complete block design with three repetitions at four locations around the Twin Cities region. Simultaneously, fourteen heirloom cultivars were selected to evaluate within-line variability. These fourteen cultivars were selected for plant
row evaluation based on bush-type architecture, maturity, and adequate yield performance. To capture a cultivar’s inherent genetic variation, sixty single plants from each cultivar were randomly chosen from 2012 field plots for pure-line trialing (Acquaah, 2012). Seed from randomly selected plants were grown as plant rows (i.e. 60 plant rows/cultivar) on the University of Minnesota’s Student Organic Farm during the 2013 growing season. Sampling for eight morphological traits (days to flowering, total nodes, canopy height (cm), pods/plant, pods in the upper two-thirds of the plant (%), total seed yield (g), 100-seed weight (g), and days to maturity) was performed within plant rows. F-tests of significance between plant rows were used to estimate variation within a cultivar. Provided significant levels of variation exist within heirloom cultivars, 8-10% of plant rows will be selected as superior lines. Gain from selection, a function of selection differential, genetic, and phenotypic variation, will be estimated during 2014 observational trials with selected material.

**Initial Results:** Preliminary stability analyses from 2013 yield trial data indicate that heirloom dry beans are generally poor performers (< 1,400 lbs./A) and do not demonstrate general adaptability. Outliers, however, suggest that particular cultivars may be both stable and higher yielding than other heirloom counterparts. Plant row analyses using F-tests of significance indicate significant variation between plant rows across all eight measured traits. Variation in canopy height, number of pods/plant, and 100-seed weight was also significant across cultivars.

**Discussion and Future Work:** Existing variation will be used to select superior lines within each heirloom cultivar and gain from selection will be estimated during the 2014 season. Ultimately, this research will result in improved pure lines of heirloom dry beans. In addition to our selection and evaluation of heirloom dry beans, we hope to explore nutritional composition using near-infrared spectrophotometry, perform culinary evaluations in conjunction with local chefs and restaurants, and obtain molecular estimates of variation to complement our phenotypic estimates this past season.

**References:**


Regional Sustainable Development Partnerships. 2013. Dry bean distributor, retail, and CSA surveys (non-published work). University of Minnesota, St. Paul, MN.

