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Johnson H W, Robinson H F & Comstock R E. Estimates of genetic and environmental variability in soybeans. *Agronomy J.* 47:314-18, 1955.

(Depts. Agronomy and Experimental Statistics, North Carolina State Coll., Raleigh, NC and US Regional Soybean Lab., Urbana, IL)

Effective selection in plant breeding is based on information about the extent to which observed differences in the traits under selection are heritable and the extent to which they are correlated with each other. This paper deals with the heritability of 24 traits in soybeans and the influence of environments on its estimation. [The SCJ® indicates that this paper has been cited in over 160 publications since 1955.]

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At the time the research was initiated, published estimates of heritabilities of important characters in soybeans, and of correlations between and among the traits, varied greatly. Procedures employed by the authors also varied, and, in my opinion at the time, there were significant problems with all the information in the literature on questions that I needed answered. With the encouragement of two very stimulating colleagues, H.F. Robinson and R.E. Comstock, I initiated the research "to clarify the whole confusing situation."

I should like to acknowledge here that my two colleagues earned fully their places as junior authors of the paper. They also contributed greatly to a most stimulating academic environment at North Carolina State University while the research was in progress.

The paper reports estimates of the heritabilities of 24 traits in soybeans and the influence of environments on the estimates. Correlations between all possible pairs of the 24 traits were reported in a subsequent paper.¹

Varieties of a crop are grown in many different soil and climatic environments, which affect the expression of important traits. Ef-

fective selection of improved varieties in plant-breeding research must therefore be based on estimates of performance in different environments. The research reported was designed to permit estimating in various combinations of environments the portion of observed variability that was due to genotypic differences among the entries involved (heritability). The results demonstrated quite nicely that, as the number of environments increased, the estimates of heritability decreased. This confirmed that estimates based on one or a limited set of environments, as were most of those published, could be misleading and give rise to inflated estimates of genetic gain from selection.

We encountered two significant problems in the conduct of the research and the analysis of the data.

The large number of traits measured, and the large number of genotypes and environments involved, resulted in a huge volume of work in making the measurements that a more experienced investigator probably would have anticipated better than we did and avoided.

By unfortunate coincidence, the data collection was completed at the time a new computer was being installed, and the analysis of the data was the first big job done on it. The first analyses that became available were extremely discouraging in that they made no sense at all. Checking a few of them on a desk calculator indicated that the new computer was not working properly. One positive aspect of the computer problem was that, in correcting it, a system of checking the analyses of data of the type involved here was designed and used throughout the life of the computer.

The large number of traits involved and the discussion of estimates of heritability published by others, in comparison to ours, probably account for the frequent citation of the paper. Subsequent research has demonstrated that our work clarified only a part of "the whole confusing situation."²

1. Johnson H W, Robinson H F & Comstock R E. Genotypic and phenotypic correlations in soybeans and their implications in selection. *Agronomy J.* 47:477-83, 1955. (Cited 100 times.)
2. Brim C A. Quantitative genetics and breeding. (Caldwell B E, ed.) *Soybeans: improvement, production, and uses*. Madison, WI: American Society of Agronomy, 1973. p. 155-86. (Cited 10 times.)