IMPROVEMENT BY MEANS OF SELECTION

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1. Introduction

One of the principal techniques for improving quality is to select those members of a population that appear to be of high quality and to reject those that appear to be of low quality. Usually the selection is based on a number of measurements that have been made on the available candidates. In personnel selection the measurements are sometimes obtained by competitive examination, the hope being that persons who obtain high marks will have superior ability for performing the subsequent tasks. In a program for improving hogs, the choice of a sire for breeding may be made after a study of his own characteristics, for example, weight at 180 days, plus those of his first few offspring.

A common feature in most selection problems is that at the time of selection we cannot measure directly the quantity which we wish to improve. Thus when a promotion from one type of work to another is in question, for example from salesmanship to an administrative task, success in the old occupation may not guarantee success in the new one. Stated mathematically, the problem is to improve some quantity y by means of indirect selection that is made from a group of tests or measurements $x_1, x_2, \ldots, x_p$.

The mathematical foundation of most of the work that has been done thus far is Karl Pearson's memoir [1] of 1902. His primary interest was in the effects of *natural* selection on correlation and variability. On the assumption that y and the x's follow a multivariate normal distribution, he gave some important theorems about the means, variances and correlations of the variates after a selection based on the values of certain of the x's. Various applications of these and other results are dispersed in the literature on personnel selection and on plant and animal improvement [2], [3], [4].

The object of this paper is to present the principal mathematical results that are useful for setting up a selection program. This part is mainly expository in character, though a few results are given in a more general form than hitherto. In addition, we shall discuss some of the problems that are encountered when we come to apply the theory to selection in practice. Here there appears to be need for much further research.

2. Statement of the problem

We shall assume that y is a continuous variate. This is not always the case in practice, since the object of selection is sometimes to draw out those who possess a specific attribute. The same general approach is valid whether y is continuous