added an additional 4¢/cut, making each cylinder cost 13.5¢. The female coupling cost $1.20, the handle, $1.50, and the yoke, including welding, $2.50. The entire cost of the sampling apparatus and 100 cores was only $18.70. A machine shop estimate for a steel head alone was $150.00 at the time the device was made. No estimate was obtained on the cylinders.

Sampling procedure for using the apparatus consists of removing the vegetation and litter and smoothing the soil. The aluminum cylinder is placed in the device and the cylinder forced into the soil until the upper edge of the cylinder is flush with the soil surface by placing a foot on top of the sampler as one would use a spade. The lower edge of the cylinder acts as its own cutting edge. The sampling apparatus is lifted from the core, leaving the metal cylinder, imbedded in the soil. The entire core is removed with a drainage spade. The soil is smoothed flush with the bottom of the cylinder by cutting with a knife. The core is placed in a paraffined, pint-sized ice cream container and sealed with masking tape. The entire process takes about one minute per core in most soils.

The sampling apparatus works well in soils with no large woody roots or stones. It has been used successfully on soils of a wide textural range: Victoria clay, Oreila clay loam, Medio fine sandy loam, Zavala loamy fine sand, and Nueces sand. Bulk densities of soils sampled varied from 1.15 to 1.53 g/cc. (Box 1961). The sandy soils must be sampled while they are moist for the soil to remain in the core.

In extremely hard soils, the yoke and handle may be removed and the cylinder and sampler driven into the soil with a sledge hammer. A board should be placed across the sampler to absorb the shock. Forcing of the aluminum cylinders into the soils sometimes damages the lower edge. However, the low cost of the cylinders allows damaged cores to be discarded and replaced.

There are several advantages to the apparatus described here over the standard steel core sampler with removable cylinders. First, the difference in cost is obvious. The low cost of sampler and cylinders allows for many more cores to be taken on a limited budget. Second, there is less compression of the soil since the cylinder itself is forced into the soil instead of a thick steel casing plus a cylinder. Third, various length cylinders may be used in sampling the surface foot of soil. Machined steel samplers must be made for a given length core. Cores of up to one foot length may be forced into the fine sands and fine sandy loams with this sampler. Fourth, the sampler can be made by most technicians from material available at good hardware stores.

The soft metal is a disadvantage. Many cores cannot be used after a dozen or so samples are taken with them in hard soil. Likewise, each core must be dug from the soil with a spade and the apparatus is useful only in studying near surface soil characteristics. However, the low cost and ease of construction makes the equipment attractive for structural studies of surface soils.

The simple construction of the core sampler and the tension table described by Learner and Shaw (1941) make soil structural studies within the limits of even the most meager budget. The equipment needed for sampling and testing for pore space can usually be made in one day for less than $20.00.

**LITERATURE CITED**


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**Direct Processing of Field Data**

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Ecological, agricultural, and range data frequently traverse a processing route which subjects the data to an unacceptable risk pattern of erroneous modification. When the processing of such data becomes routine and involves the utilization of a computer facility, most of the detectable errors arise in the phase of the processing route which lies between the actual initial data recording and its submission to the computer for data reduction. This includes re-transcription of the data and subsequent key-punching with verification.

In an operation of small to moderate scope and involving a normal turn-over of support personnel, the frequency of errors arising from re-recording of data can be expected to be moderately high. These errors may be both difficult and expensive to detect and to correct. The experiences of the authors have shown that such errors are primarily the result of either random mistakes or misunderstandings of instructions. While both types of errors are costly, the latter becomes extremely so when large volumes of data are involved.

In addition to the errors arising from data handling there exists the inconvenience that the usual elapsed time from the initial recording of data in the field to the storing of it in a suitable punched card format runs from a minimum time of one week up to several weeks. This means that visual scanning of new data in a meaningful and useful dis-
play is delayed for at least an equivalent period of time. In turn, then, the feasibility of in-the-field verification of doubtful results is significantly reduced; whereas, with a rapid data-display return the opposite could be true.

While there may be several ways of overcoming most of these objectionable characteristics of this route of data acquisition, there exists one which may prove to be superior to others from both the practical and economical points of view. This procedure involves the use of special data acquisition forms for use with an optical reader attached on-line to a small computer. The actual facility utilized by the authors for this purpose is located in the Statistical Laboratory of Colorado State University; it includes an IBM 1231 Optical Mark Reader attached on-line to an IBM 1401 computer with card, tape and printer input-output devices.

The 1231 is a sensing device capable of detecting and translating markings from an 8½ x 11 inch sheet of paper into records in the memory of the computer. The interpretation and manipulation of the records can be accomplished through programs in such a fashion that the data from the 1231 sheets are simultaneously punched on cards, stored on tape and listed on a print out.

Fig. 1 shows the form we are using in an ecological study of alpine vegetation. Area identification is marked with a black felt pen marker by the observer directly on these sheets; the presence of a species in a given sample plot is then indicated by similar marks in the tracks following the code number of that species. These data sheets are processed without additional error providing the investigator with a data listing and a deck of punched cards. Such processing of data sheets can be performed at the rate of 1,500 to 2,000 per hour, thus providing the investigator with an immediate display of recently acquired data. Utilizing the described computing facilities we find that the processing cost per document exclusive of card cost is about 2¢ each; utilizing the equivalent facilities of the same institution in the manner described at the beginning of this report, the processing cost per document is about 6¢ each.

Briefly, then, utilizing this type of data acquisition, significant increases in efficiency are obtained with regard to:
1. Accuracy of data procurement.
2. Processing time.
3. Direct costs of data acquisition.
Sample forms will be sent to readers upon request.