A MACRO SOIL CORING DEVICE

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INTRODUCTION

Soil and plant scientists are often interested in obtaining soil cores of the entire root zone of the commonly grown cereal varieties. In the semiarid climate at Swift Current roots penetrate to a depth of 120 cm with the 60 to 120 cm zone often being critical for plant survival under drought conditions (1). To facilitate research on the entire root zone a soil coring device was developed capable of taking cores 15 cm in diameter, 122 cm deep. For *in situ* studies the soil cores are taken in a sheet metal tube, then replaced in the soil. This requires a minimum disturbance of the soil surrounding the core with the gap between the core and the surrounding soil kept to a minimum.

A sampling tool reported by Kelly et al. (2) did not meet the minimum disturbance and minimum gap criteria while the tool reported by Robertson et al.(3) did not meet the depth specification required as well as the minimum disturbance criteria. To meet this minimum disturbance specification we decided to obtain a core by pushing a probe into the soil without using a rotating or auger-type of bit.

CONSTRUCTION

The coring device was mounted on a motor grader (Fig. 1) which provided a mobile power source with sufficient weight to achieve penetration to 122 cm. A large tractor or loaded truck could also be used. The grader weighs 6810 kg (15,000 lb) on the rear axle, which results in a downward force of 5400 kg (11, 900 lb) on the probe.

The grader frame was extended to provide mounting pivots for the coring device. The mast framework was constructed of 10 x 10 x .635 cm (4 x 4 x 1/4 in.) tubing with a double 20 cm (8 in.) channel upper cross-member. The sliding lower cross-member was made of two pieces of 15 cm (6 in.) channel and was heavily reinforced between the hydraulic cylinder connecting points. The upper and lower cross-members have a guide in the center which allowed the probe-driver to slide through and be repositioned with each stroke of the hydraulic cylinders. The probe (Fig. 2) was readily connected to or disconnected from the probe-driver by the coupler (Fig. 1).

The probe (Fig. 2) was made from a standard 15 cm (6 in.) pipe with a replaceable cutting bit. The bit was machined from mild steel and has a smaller inner diameter than the probe. It provided a seat for a sheet metal holding tube which can be placed in the probe to receive

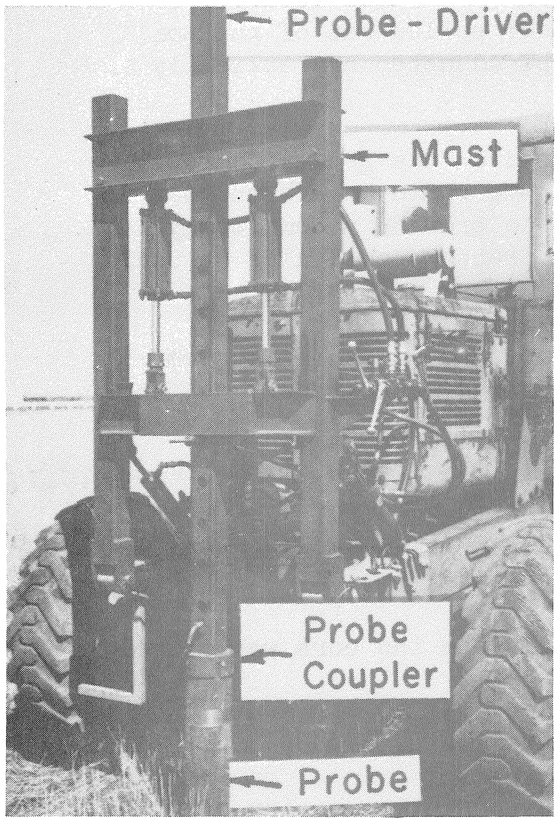

Figure 1. Coring device mounted on a grader taking a soil core.

Figure 3. Placing holding tube in probe.

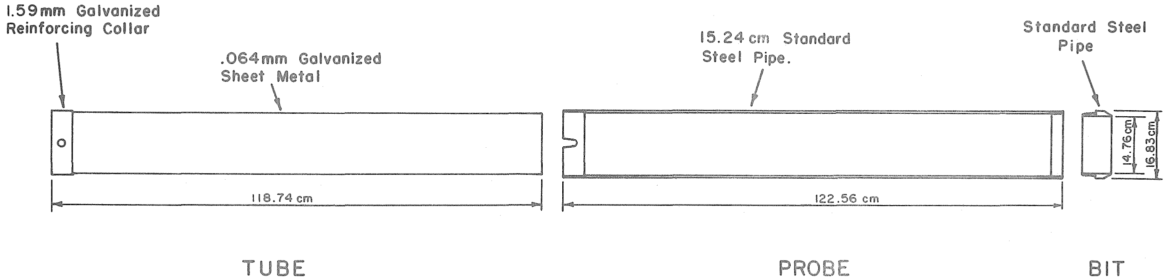

Figure 2. Probe and holding tube.

the soil core. Two hydraulic cylinders were used to reposition the lower cross-member. Thus, by placing the pin in successive holes in the probe-driver the probe was either pushed in or pulled out of the soil. The mast's vertical angle of elevation can be adjusted hydraulically to ensure plumb operation of the probe.

A separate hydraulic system was mounted on the grader to power the coring device. The grader's hydraulic pump could have been used as the power source but it was more convenient to provide a completely separate system. The hydraulic system of a tractor could also be used to power the coring device.

The mast framework, probe-driver, probe and hydraulic systems were of sufficient strength to support the rear of the grader with the wheels off the ground.

OPERATION

The procedure for isolating a soil core for the *in situ* studies was as follows:

(a) The sheet metal tube used to hold and isolate the core was placed into the probe (Fig. 3).

(b) The probe was attached to the probe-driver (Fig. 1).

(c) The probe was pushed into the soil by a sequential motion of the hydraulic cylinders and repinning the probe-driver (Fig. 1). Removal of the probe was accomplished by a similar procedure with the pin above the lower cross-member. For approximately the latter half of the probe removal sequence, the probe-driver must be pinned above the upper cross-member to prevent the probe from falling back into the hole when the lower cross-member was being repositioned and repinned relative to the probe-driver.

(d) The soil core was generally held firmly by the bit which is of smaller diameter than the probe. To facilitate removal of the tube with the core intact the probe was lowered onto a specially constructed pad which pushed the core clear off the bit and completely into the tube (Fig. 4).

(e) The tube with the core intact was removed from the probe by means of a special removal tool (Fig. 5).

(f) The bottom end of the tube was capped with a perforated metal cover (Fig. 6). This holds the soil core in the tube while it is replaced into the soil but allows aeration of the soil column.

(g) A 50 x 50 cm, 10 mil plastic apron (Fig. 7) was pulled tightly over the top of each tube. This prevented water from running down the space between the tube and the soil and thus wetting the core from the bottom.

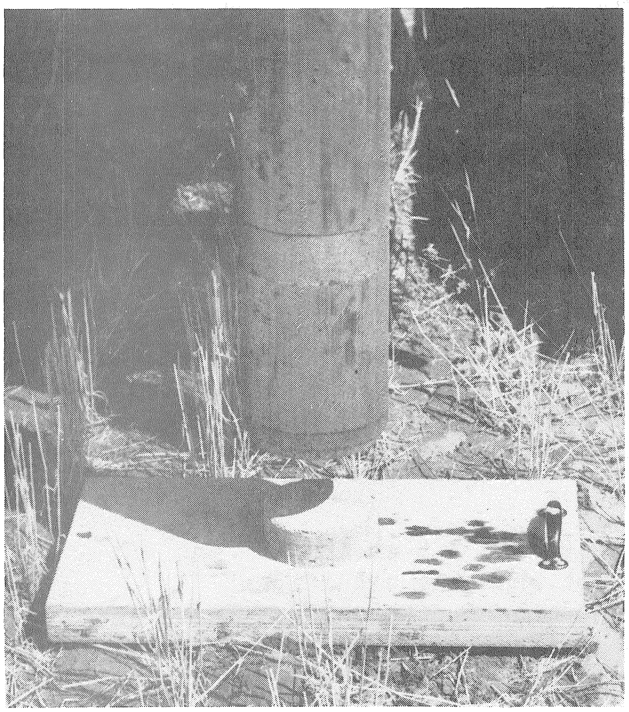

Figure 4. Pad for pushing the soil core through the bit.

Figure 5. Removing the tube with the soil core intact.

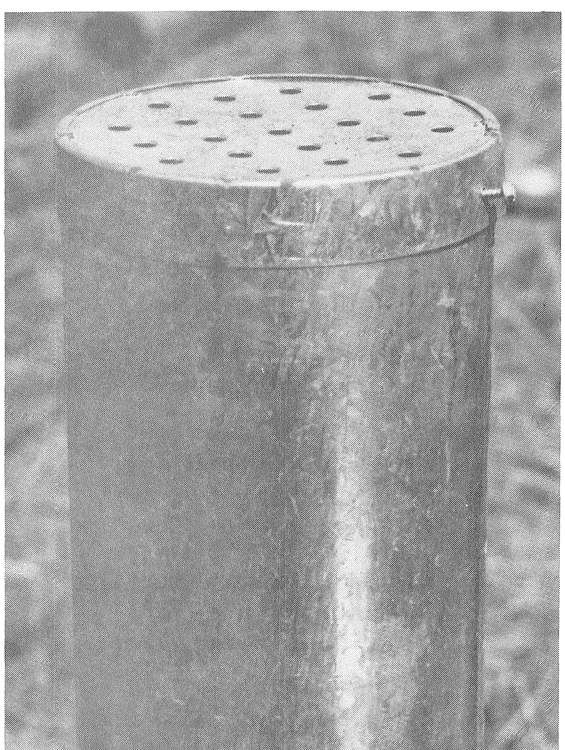

Figure 6. Cap for holding tube.

Figure 7. Soil core replaced in situ and sealed with a plastic sheet.

(h) Periodically during the growing season the tubes were removed and taken to the laboratory for analysis. The tool illustrated in Figure 5 was used to withdraw the tubes from the soil. To remove the soil core from the tube with minimum disturbance, a pneumatic chisel was used to cut the tube on the opposite sides (Fig. 8). The tube was then discarded.

(i) The soil core was cross sectioned with a sharp knife (Fig. 9) for analysis.

PERFORMANCE AND DISCUSSION

The procedure described by points (a) to (g) above took about 5 to 7 minutes for each core. One hundred and seventy cores were isolated in 20 hours. Two standard 8-inch stroke hydraulic cylinders were used to reposition the lower cross-member for reasons of availability and economy. Using hydraulic cylinders with a stroke of 24 inches or more would speed up the operation.

Some slight compaction of the core (about 2.5 cm in 122) was visually evident; however, the data did not show any significant variation from densities obtained by other methods (Fig. 10). The high precision and repeatability of the method was illustrated in Figure 11. This indicates the method is suitable for taking and isolating undisturbed soil cores to a depth of 122 cm.

A soil core can be taken without placing it in the tube if isolation is not desired, although the tube is a convenient way of transporting the core to the laboratory. To destroy the tube during sampling is an expensive procedure and plans are underway to develop a device to push the core out of the tube without destroying the tube and, hopefully, without compacting the core. This may not work in all cases, especially after the core has been in the tube for a period of 3 or 4 months.

COSTS AND PLANS

The cost of parts and materials for the coring device is approximately \$600. The material used to fabricate 170 tubes cost approximately \$500. Detailed plans are available from the Agriculture Canada Research Station, Swift Current.

REFERENCES

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3. Robertson, W.K., Pope, P.E. and Tomlinson, R.T. 1974. Sampling tool for taking undisturbed soil cores. Soil Sci. Soc. Amer. Proc. 38: 855-857.

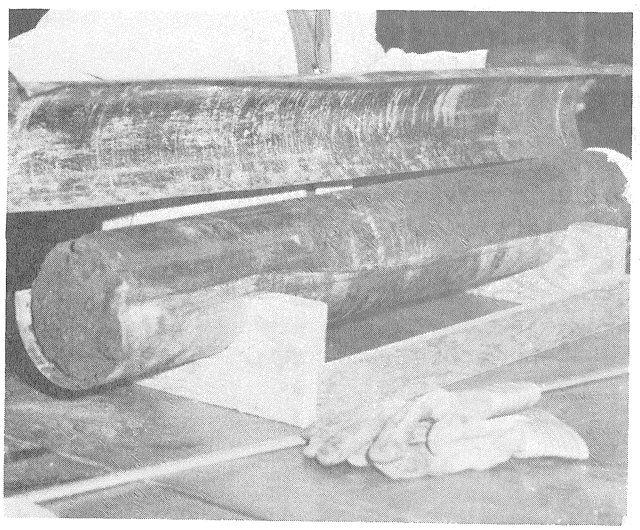

Figure 8. Removing the core from the holding tube.

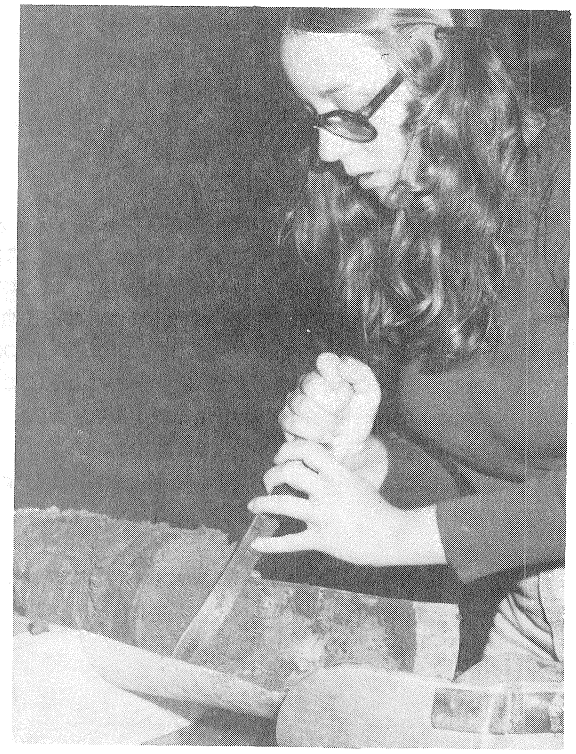

Figure 9. Sectioning soil for analysis.

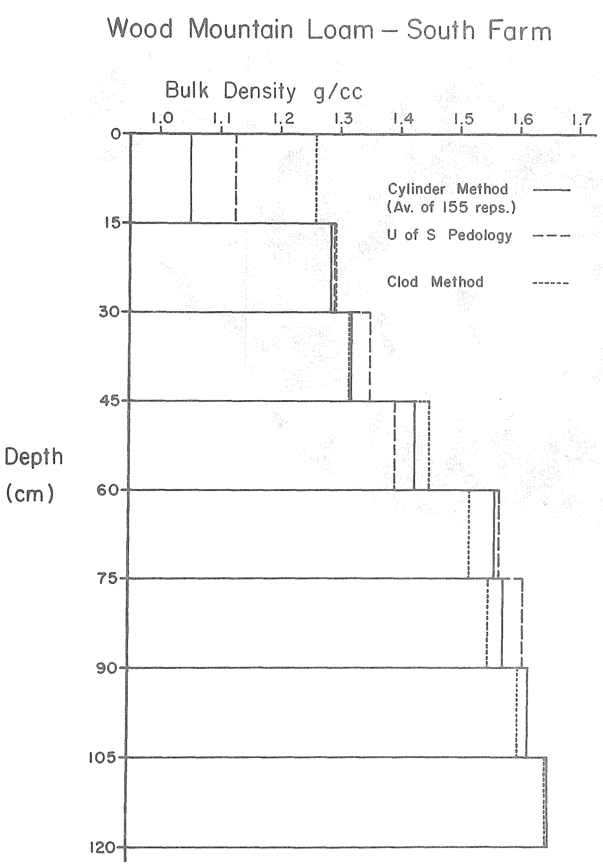

Figure 10. Comparison of three methods of sampling for soil density.

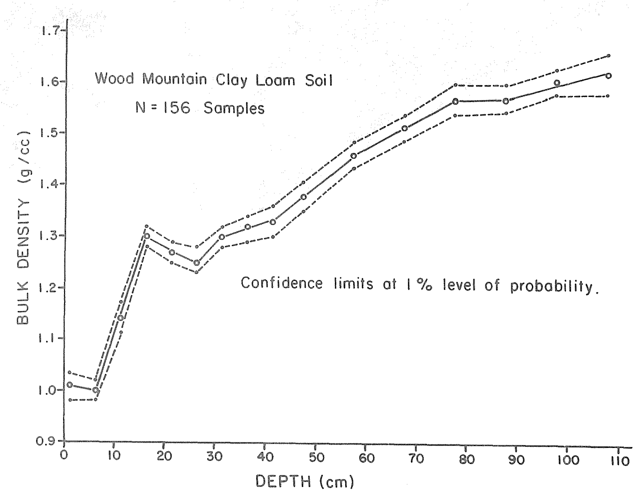

Figure 11. Precision obtained by using the Macro Coring Device.