1968-69 annual report

Water Resources Research Center

UNIVERSITY OF HAWAII
HONOLULU, HAWAII

EVAPOTRANSPIRATION BY SUGAR CANE

SUPPORT:
Office of Water Resources Research Allotment Project No. A-014-HI
Hawaiian Sugar Planters' Association

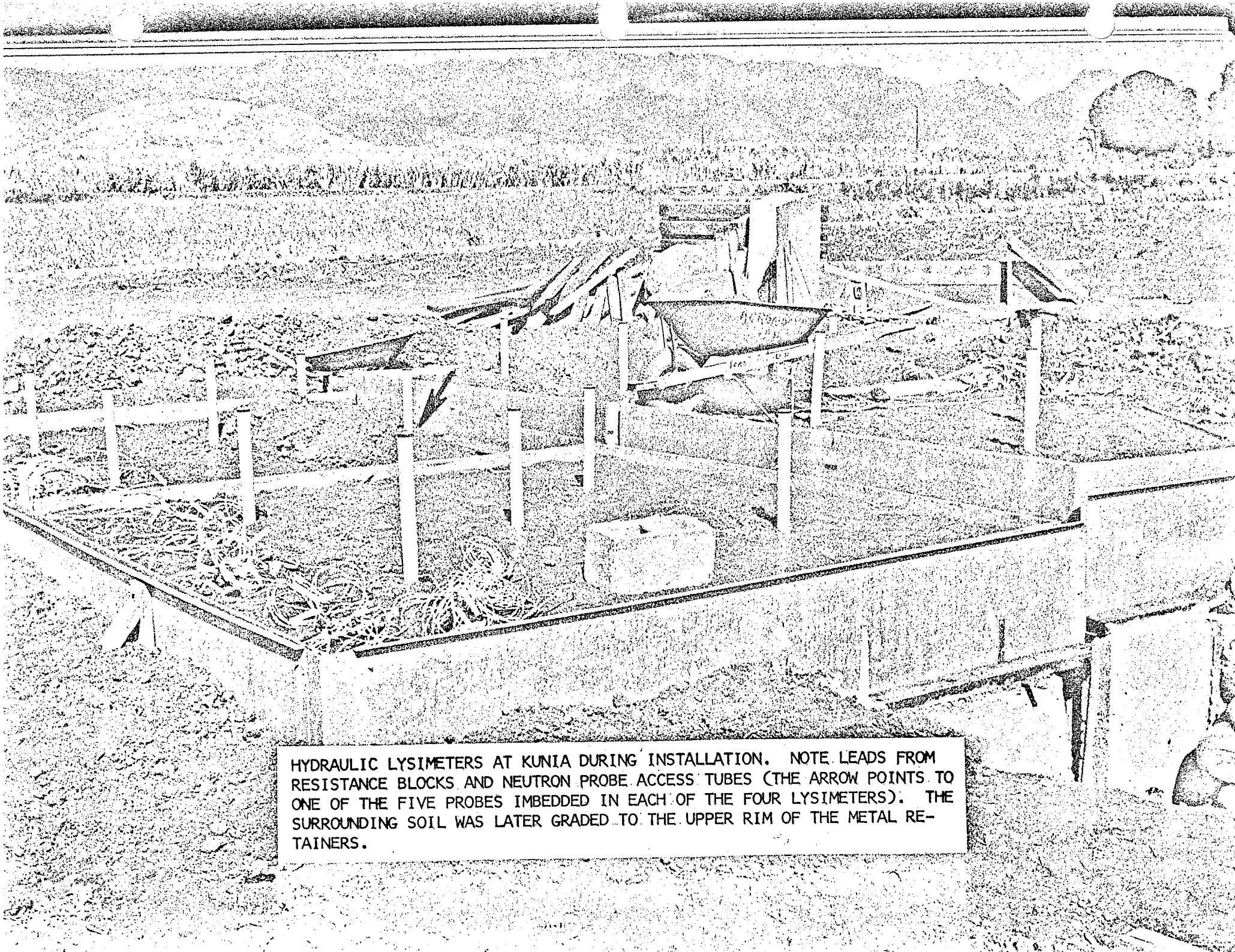
Project Period:
July 1, 1967 to September 30, 1969

PROJECT PERSONNEL

Principal Investigator:

Paul C. Ekern

Prem C. Prasad, Gong Yuh Lin



HYDRAULIC LYSIMETERS AT KUNIA DURING INSTALLATION. NOTE LEADS FROM RESISTANCE BLOCKS AND NEUTRON PROBE ACCESS TUBES (THE ARROW POINTS TO ONE OF THE FIVE PROBES IMBEDDED IN EACH OF THE FOUR LYSIMETERS). THE SURROUNDING SOIL WAS LATER GRADED TO THE UPPER RIM OF THE METAL RETAINERS.

EVAPOTRANSPIRATION BY SUGAR CANE

Objectives

The objectives of this study are:

(i) Design and installation of a large hydraulic lysimeter within a major irrigated sugar cane region.

(ii) Calibration of this instrument as a primary index for evaporation of water from Latosols and successive growth stages of sprinkler irrigated cane.

(iii) Calibration of neutron probes in tropical soils.

(iv) Assessment of the patterns of moisture movement within the lysimeter by resistance blocks and the neutron probes.

(v) Measurement of the heat budget within the soil.

(vi) Correlation of the measured consumptive use with pan evaporation and other soil and meteorological parameters for the prediction of irrigation scheduling.

(vii) Collection of seepage waters for detection of the rate of movement of nitrates and other constituents through the soil profile into ground water.

Research Accomplishments

The lysimeters were set with transplanted cane in flat-bed culture under sprinkler irrigation in October 1968. Initial water-use rates showed widely fluctuating cane-use/pan ratios related to strong positive advection of heat not unlike those reported by Ewart (Fig. 1). The April cane-use rates with full canopy (final leaf area index 3.0) were 93 percent of a class A pan 1 foot above ground (Fig. 2). The actual neutron moisture calibration curve for the soil departed sharply from the factory standard (Fig. 3). Neutron probe estimates of soil water verified the extreme lag in the response of resistance blocks to soil-moisture stress under field conditions (Fig. 4). The laboratory calibration curve (Fig. 5) for the blocks was valid only when the blocks were enmeshed by the root systems (Figs. 6 and 7). The root systems seemed to be confined to the uncompacted surface layers as evidenced by the limited withdrawal of water measurements by the neutron probe in the deep subsoil layers (Fig. 7). Percolate from heavy winter rains removed large amounts of nitrate during the early stages of plant growth, but subsequent irrigation removed only

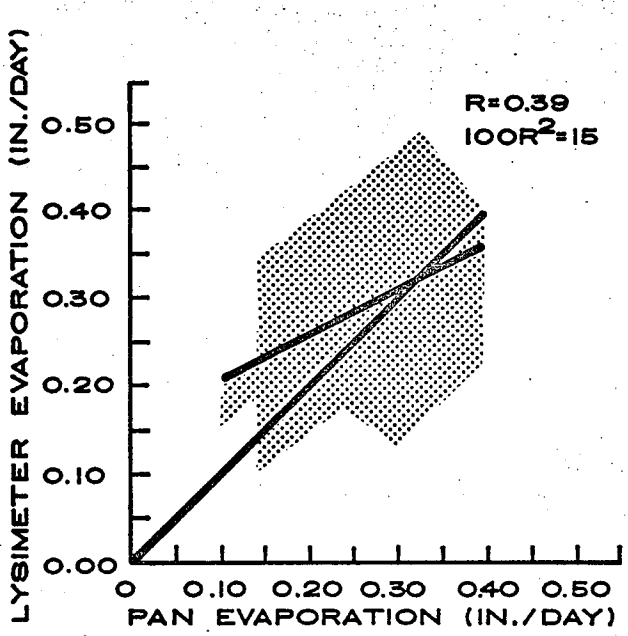


FIGURE 1. RELATIONSHIP BETWEEN PAN EVAPORATION AND SUGAR CANE EVAPOTRANSPIRATION. STIPPLED AREA REPRESENTS THE SCATTER DIAGRAM. (AFTER EWART)

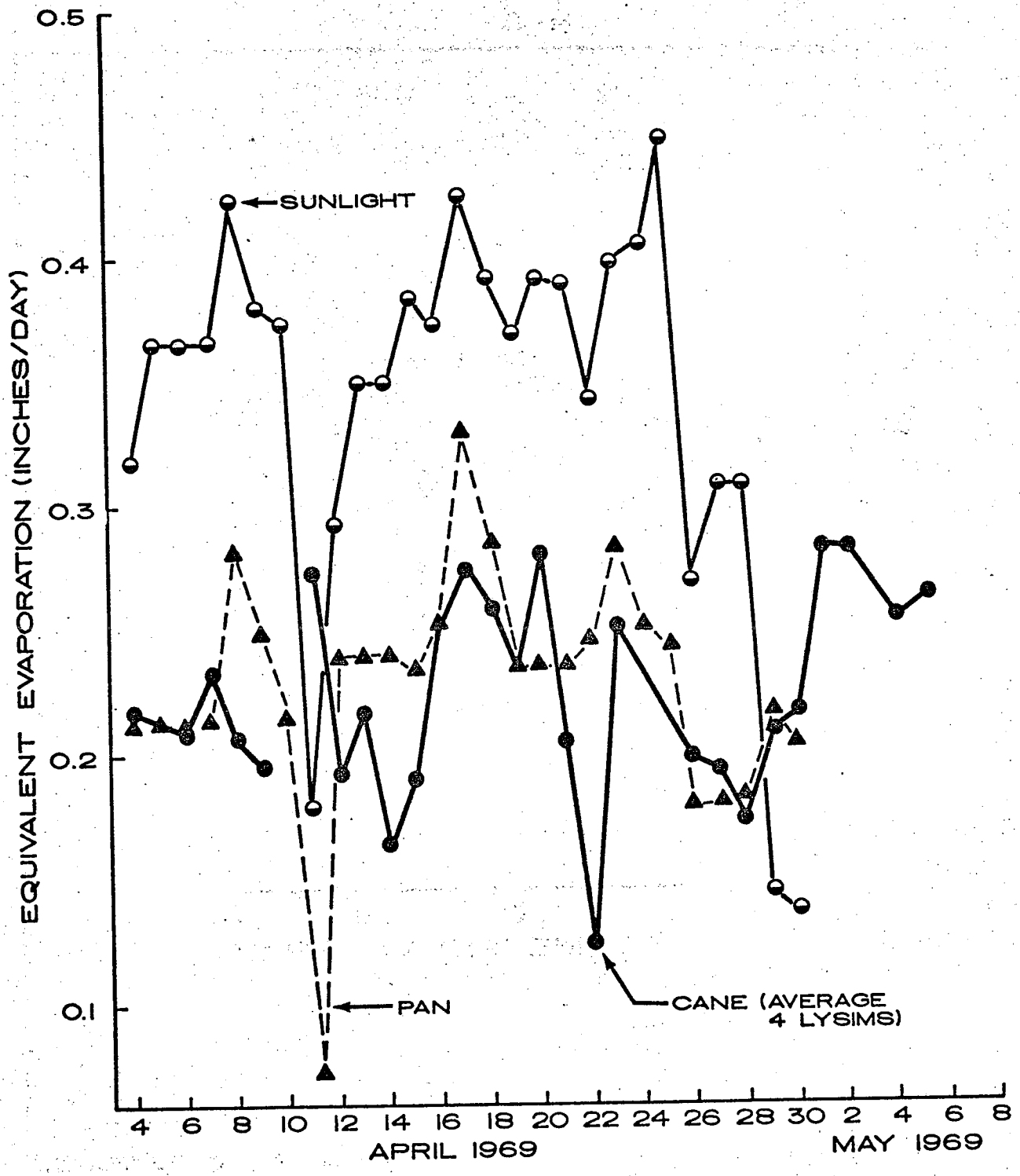


FIGURE 2. RELATIONSHIP AMONG PAN EVAPORATION, SUGAR CANE EVAPOTRANSPIRATION, AND SUNLIGHT FOR KUNIA.

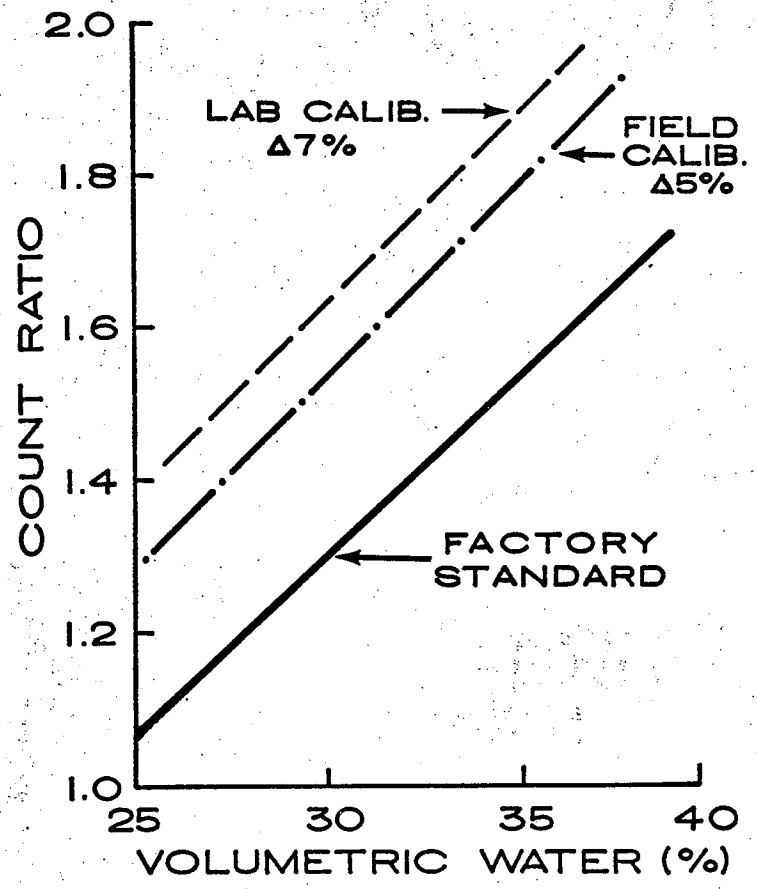


FIGURE 3. LABORATORY AND FIELD CALIBRATION FOR THE NEUTRON PROBE IN MOLOKAI SOIL COMPARED TO THE FACTORY CALIBRATION.

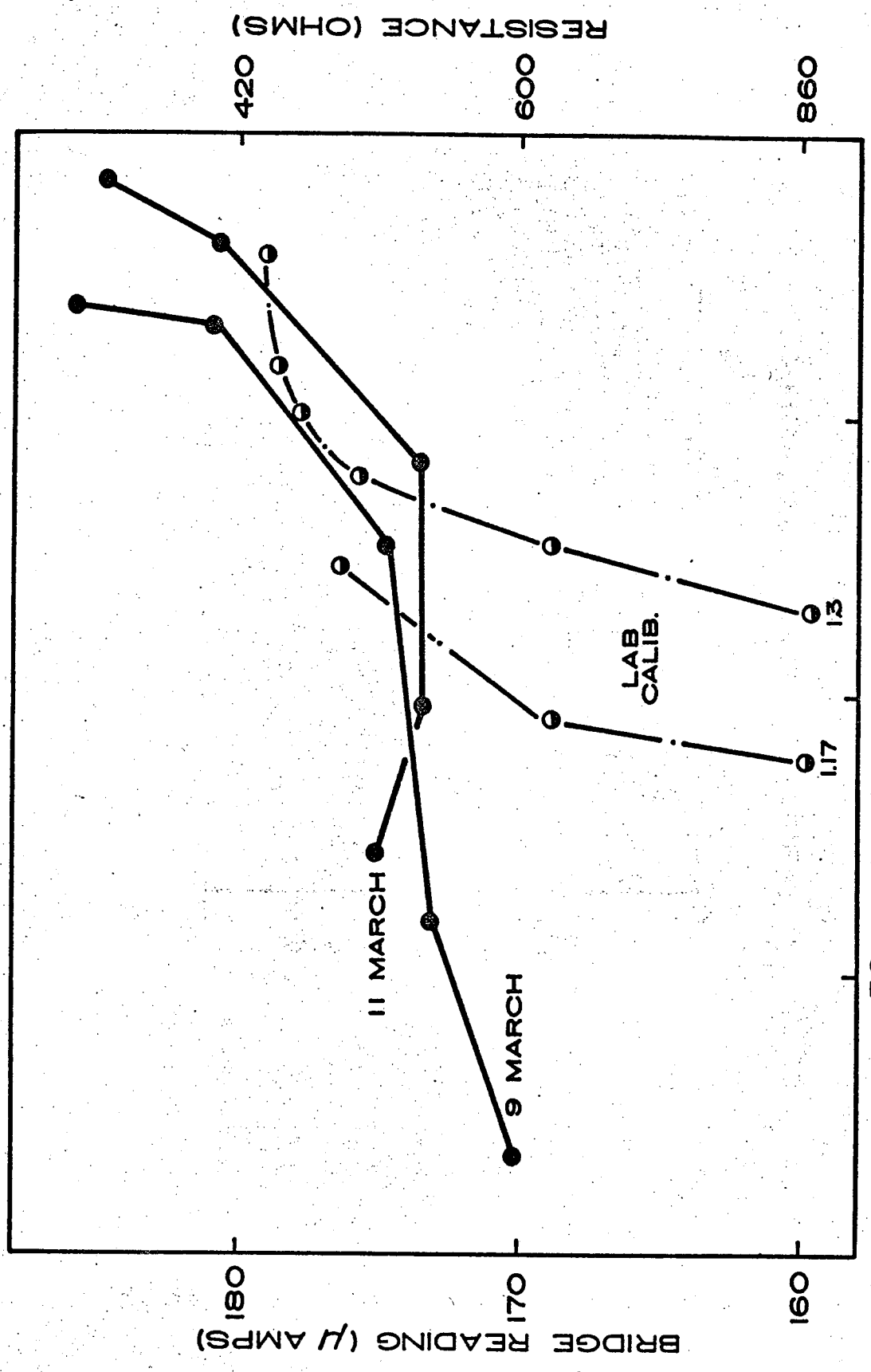


FIGURE 4. FIELD VERSUS LABORATORY CALIBRATION OF THE RESISTANCE BLOCK AGAINST SOIL MOISTURE.

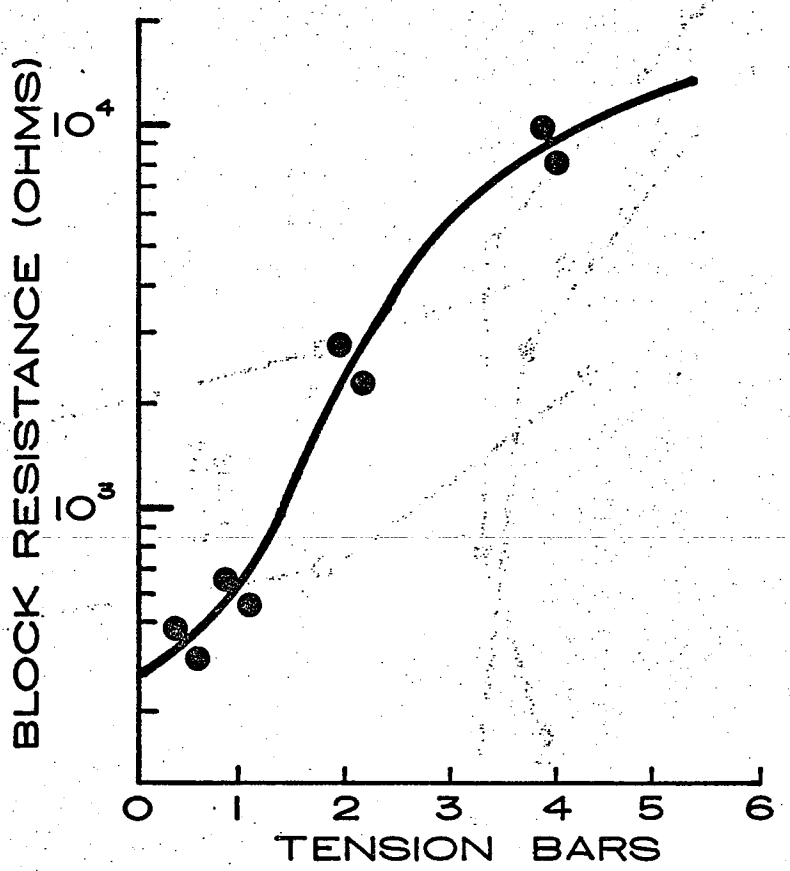


FIGURE 5. LABORATORY CALIBRATION OF RESISTANCE BLOCK FOR THE MOLOKAI SOIL.

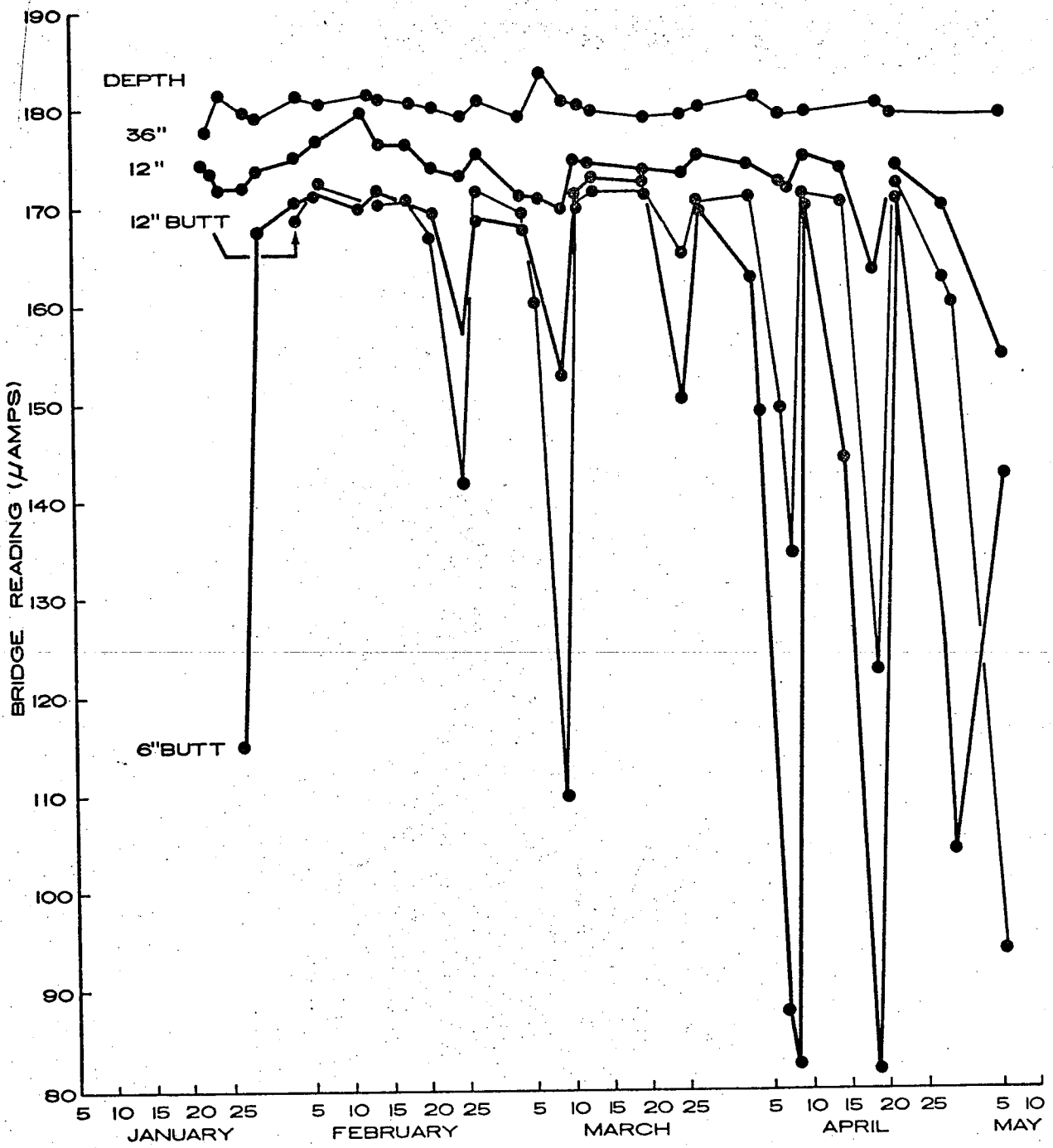


FIGURE 6. ROLE OF DEPTH AND PLACEMENT OF THE RESISTANCE BLOCK ON FIELD RESPONSE TO MOISTURE WITHDRAWL.

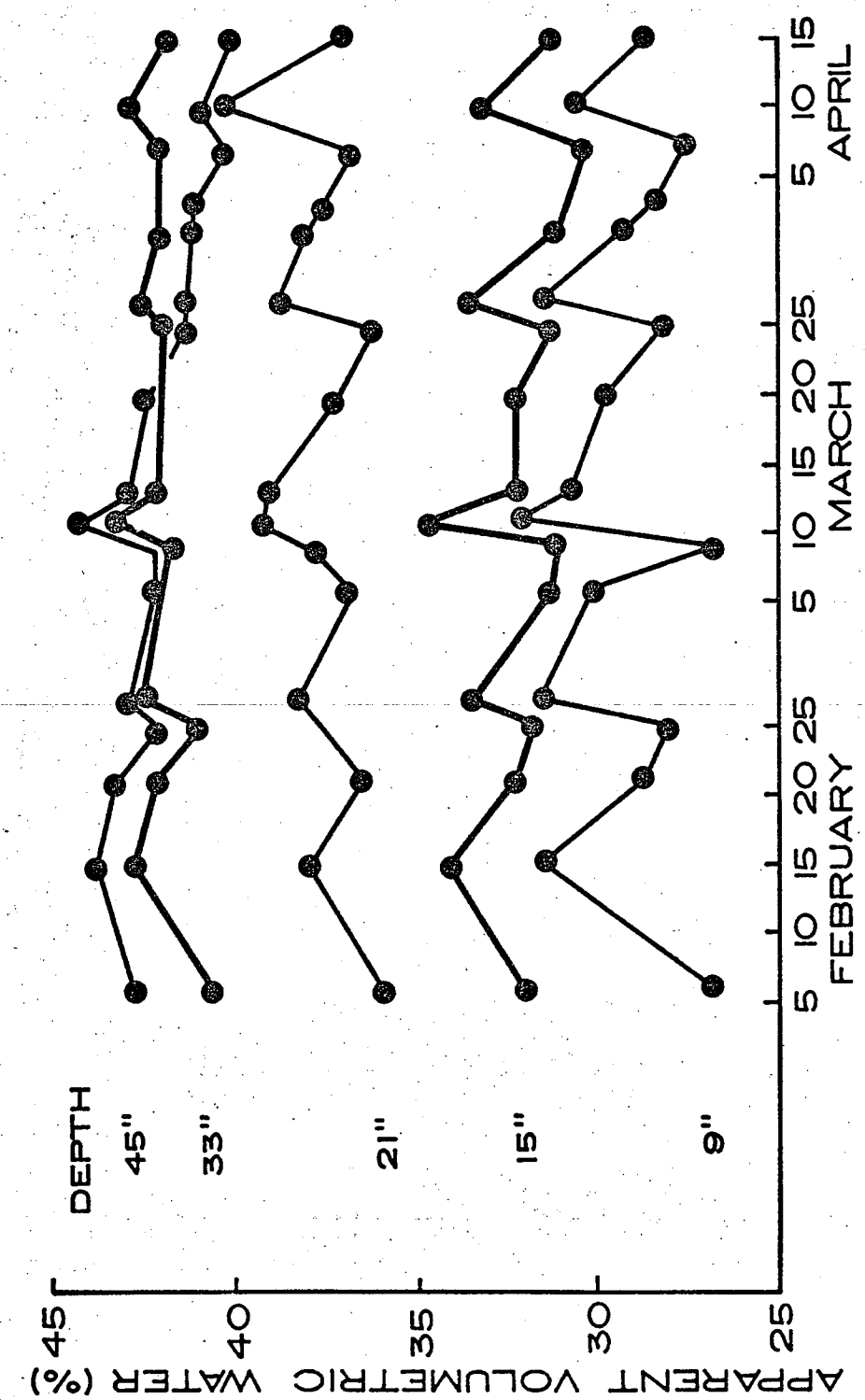


FIGURE 7. PATTERN OF MOISTURE WITHDRAWL MEASURED BY NEUTRON PROBE IN THE LYSIMETERS.

small amounts of nitrate after the plant matured (Figs. 8a and 8b). Significant loss of chloride, sulfate, silica, and other solubles continued unabated as the cane grew. Sprinkler irrigation applied at rates much less than the potential intake of the soil resulted in substantial reduction in the available water stored in the soil when it was rewetted on the sorption branch of the hysteresis loop (Fig. 9).

Status of the Project

The first phase of the work has been completed and will have a fianl report in September 1969.

Results Expected to be Accomplished

The cane was harvested in May 1969. The second phase will record water use of bare soil and the ratooning cane. The extent of renewed leach of nitrate prior to the regrowth of the cane is a matter of some importance.

Publications

Ekern, Paul C. 1968. *Consumptive Use of Water by Sugarcane.* 27th Annual Conference, Hawaiian Sugar Technologists, p. 57-58. Also summary in HSPA Annual Report.

Paper for November 1969. The Meeting of Soil Science Society of America, Detroit.

A project completion report is in preparation.

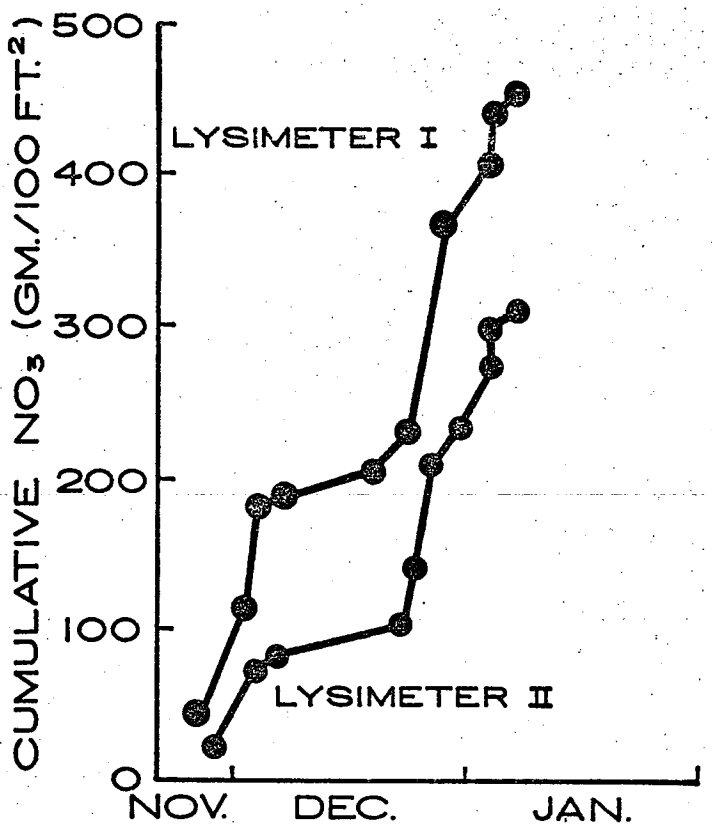


FIGURE 8a. CUMULATIVE REMOVAL OF NITRATE IN THE LEACHATE FROM THE LYSIMETERS.

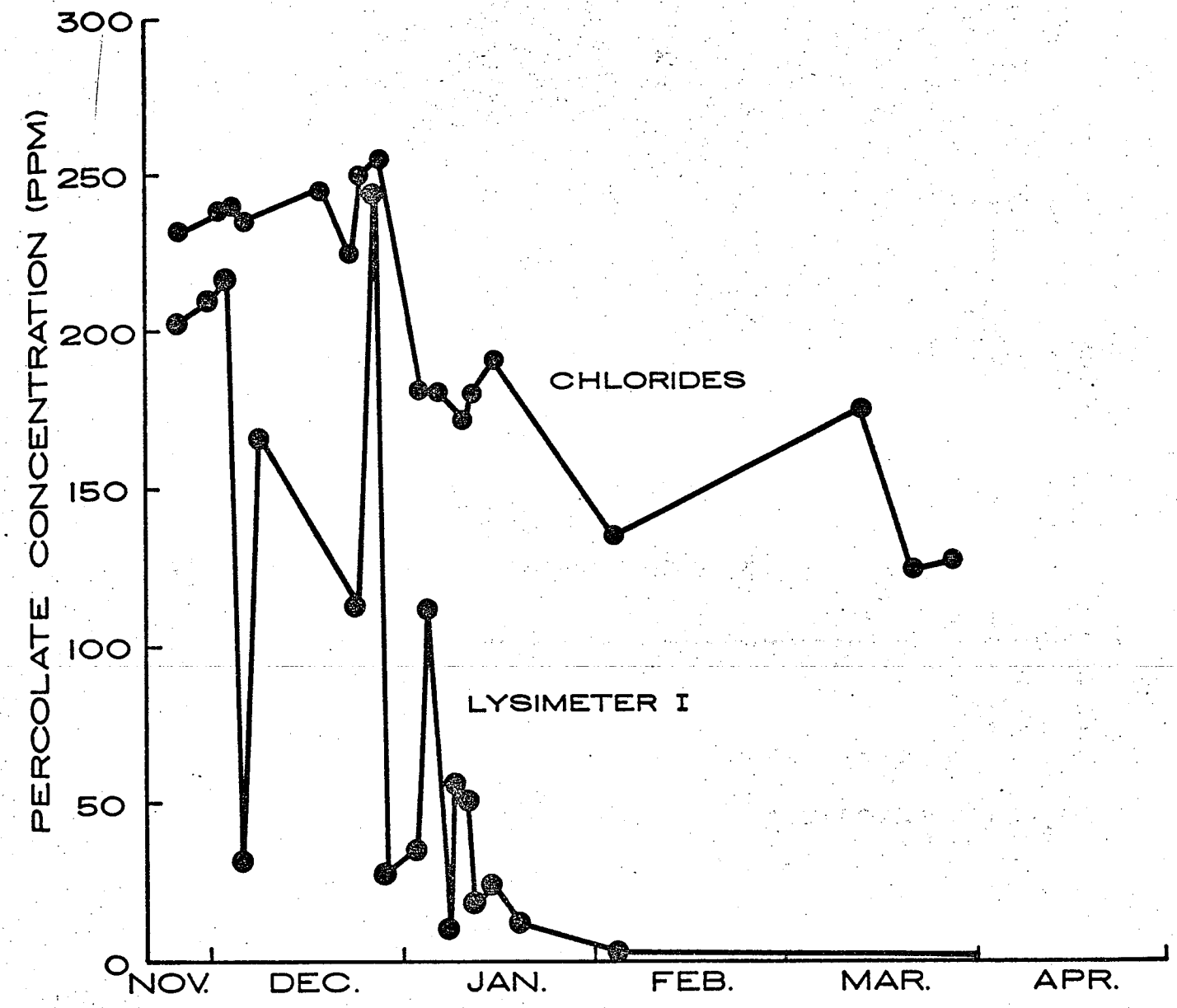


FIGURE 8b. CONCENTRATION OF SOLUTES IN LEACHATE FROM THE LYSIMETERS.

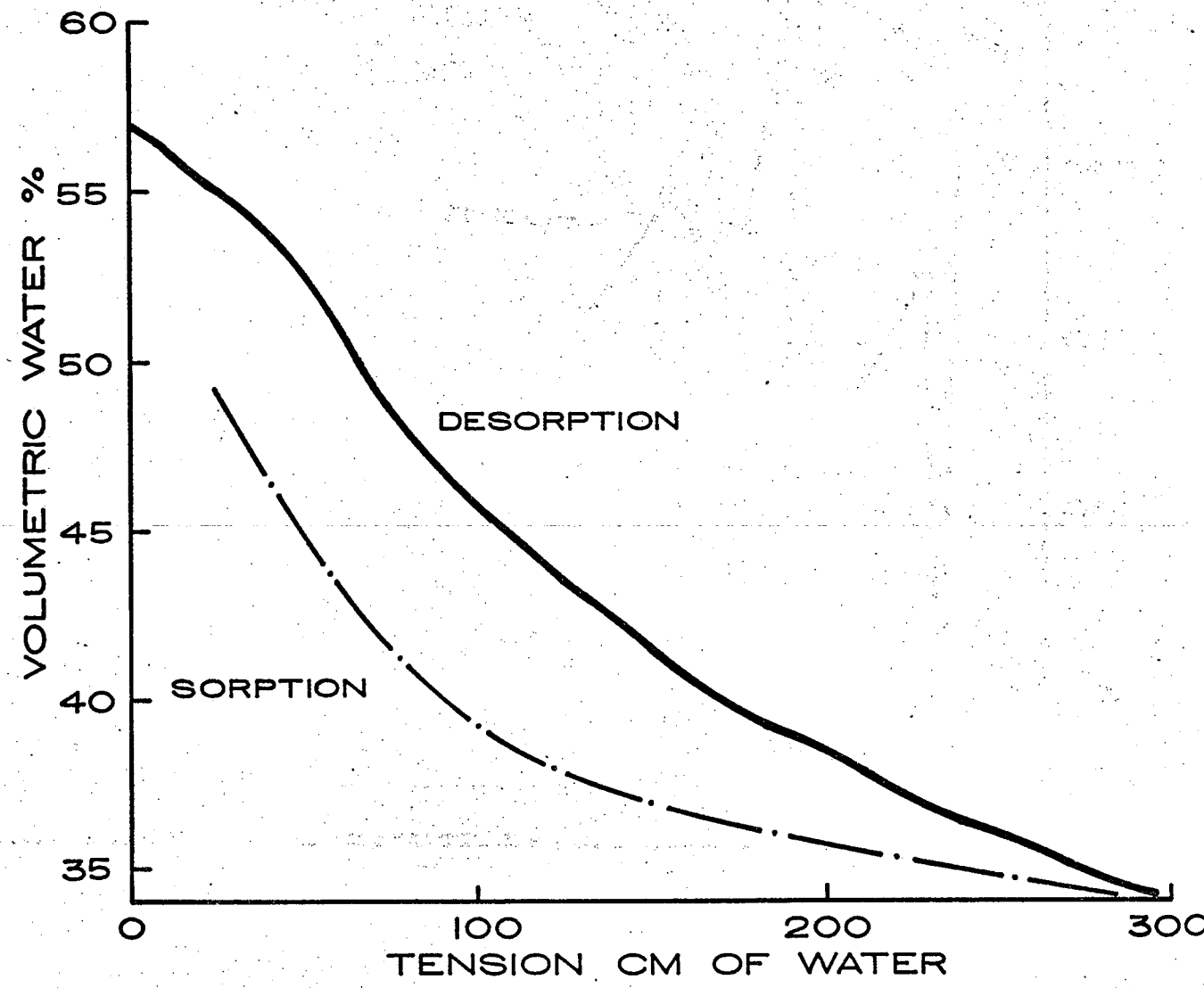


FIGURE 9. HYSTERESIS OF SORPTION AND DESORPTION OF WATER FROM MOLOKAI SOIL.