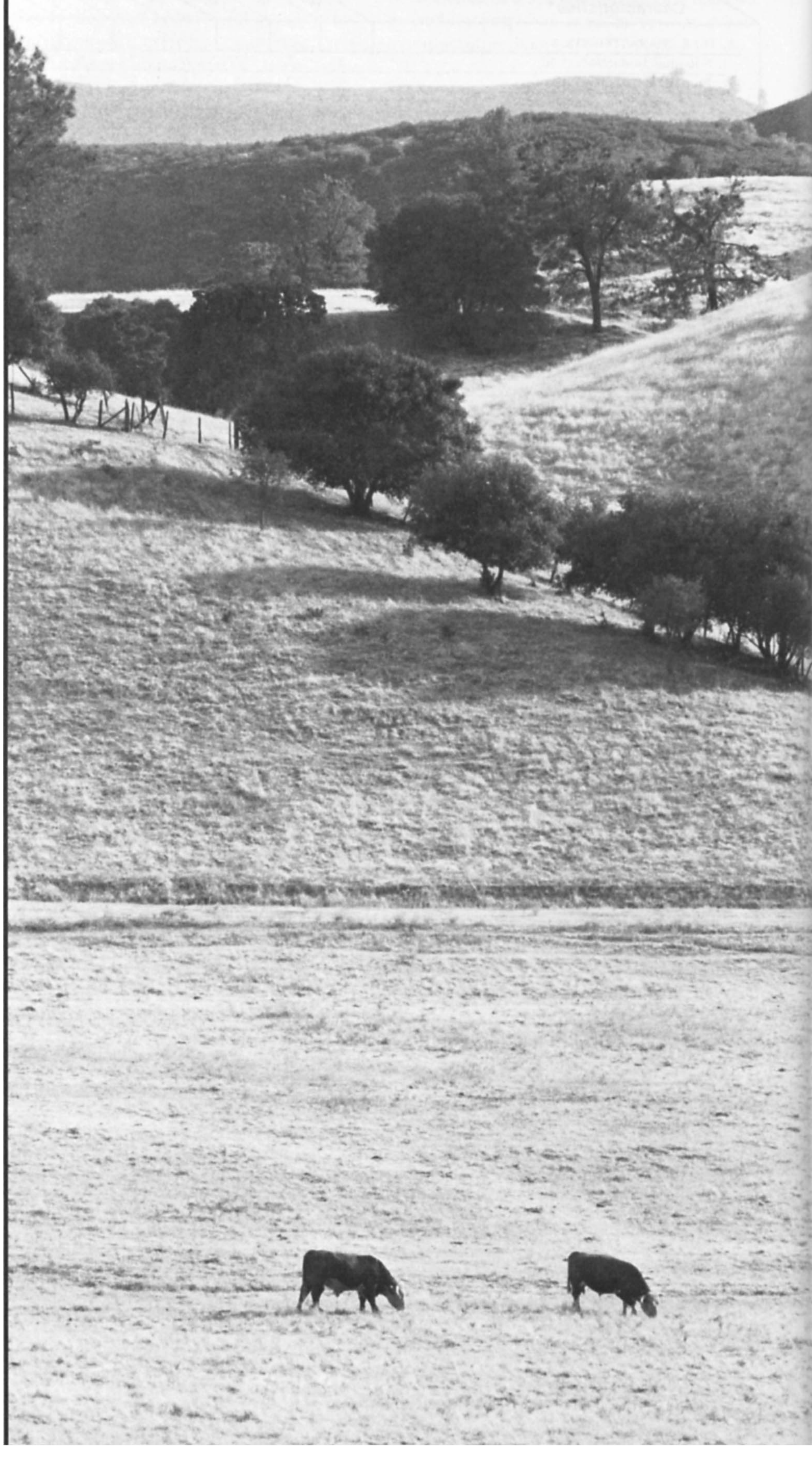
Jack Kelly Clark

Plant cover helps control rangeland soil



The Sierra Foothill Range Field Station, east of Marysville, is typical of at least 405,000 hectares (ha) (1 million acres) of California rangeland. Because of its representative combination of soils, vegetation, slope, and climate and because it is a secure research area, the station is an ideal location for long-term studies of natural processes. One such process is soil erosion.

Soil erosion by water is a two-part process. First, the impact of raindrops detaches soil particles from the main mass of soil. Then, water flowing over the soil surface transports this loose soil from the site of detachment. This process is affected by six factors: rainfall amounts and intensities (R), soil erodibility dependent upon inherent soil properties (K), length of slope (L), percent slope (S), amount of soil covered by vegetation (C), and erosion control practices (P). These six factors have been combined into an equation called The Universal Soil Loss Equation (equation 1).

$$\text{Annual soil loss/acre (A)} = RKLSCP \quad [1]$$

Each of these factors is important in predicting the long-term average annual soil loss from an agricultural area. Details for derivation of these factors and application of the equation are presented in W. H. Weishmeier and D. D. Smith, *Predicting Rainfall Erosion Losses— A Guide to Conservation Planning,* U.S. Department of Agriculture Handbook 537, 1978. The equation can be used separately in either the English or metric system.

The equation was developed in the midwestern states, and although it is used frequently in the West, few data have been collected here to test its validity and usefulness. An experiment was initiated at the Sierra Foothill Range Field Station in 1974 to test the equation on one extensive range soil. This is a progress report on the first five years of the study.

Six 22- by 1.8-meter (72.6- by 6-foot) erosion plots were established on a 9 percent slope. Each plot was enclosed on three sides by aluminum edging. The low end of each plot was equipped with a sheet-metal trough that funneled water and soil into a slowly permeable cloth sack. After each rainstorm

erosion

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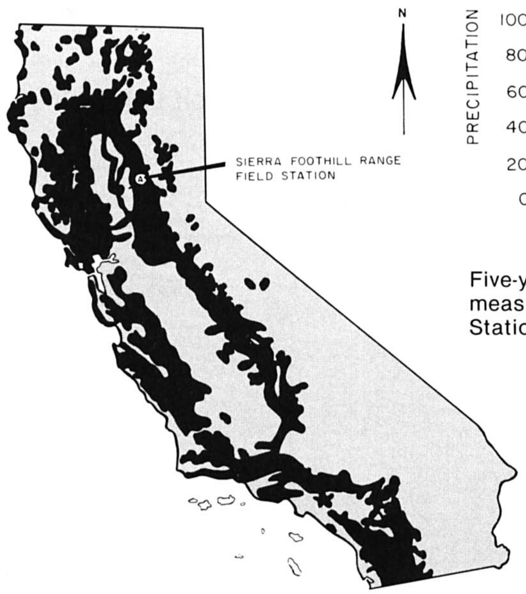
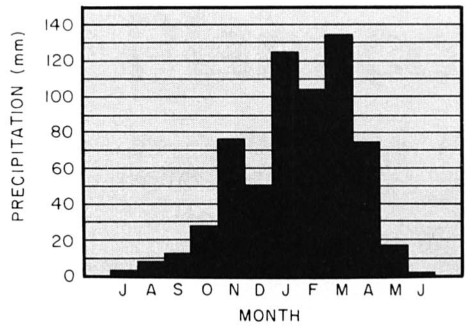


Approximate extent of California rangeland. Sloping site of field station is typical of about a million acres of this range.



Five-year average monthly precipitation measured at Sierra Foothill Range Field Station Auburn Series soil plot.

the soil trapped in the cloth sack was brought to the laboratory, dried, and weighed.

Four plots were tilled up and down slope using an 8-horsepower rotary tiller and were raked up and down slope to break up large clods. No erosion control practices were established on the plots. These four plots are in "standard" condition such that LSCP = 1 for equation 1. Two plots were left in the natural grass cover. The main grasses were wild oats (*Avena barbata* Brot.) and soft chess (*Bromis mollis*). The entire six-plot area was enclosed by a fence to exclude grazing animals.

The soil at the site is in the Auburn Series. It is a shallow gravelly soil (loamy, mixed, thermic Ruptic-Lithic Xerochrepts) quite typical of those formed on metamorphosed volcanic rocks at lower elevations in the Sierra foothills. In addition to measuring soil loss, we also measured rainfall amount and intensity for each storm.

Data for 1976 and 1977 clearly show the two years of drought, when rainfall and soil loss were very low. The years 1978 and 1979 were close to the 20-year average precipitation measured at the station of 940 mm (37 inches). As shown by the five-year rainfall distribution at the site, January, February, and March are the months with the most rainfall and the highest potential for soil loss (see graph).

The R value, a measure of the storm's ability to erode soil (its erosivity), combines rainfall amount and intensity. A wide range of R values has been calculated for the five years. This variability is due to amount, intensity, and timing of the rain storms during the year. These R values are used to calculate K values for the soil through equation 1. When LSCP = 1, equation 1 becomes equation 2.

$$K = A/R \quad [2]$$

The K factor is a measure of soil erodibility. Its value may range from 0.0 to 1.0. As the K value gets larger, the erodibility of the soil is higher. K values above 0.35 indicate high susceptibility to erosion. The Auburn soil has very low erodibility, with a five-year average K value of 0.03.

The K value calculated from these measurements is far below the 0.22 to 0.30 value currently estimated for the soil through a system outlined in Agricultural Handbook 537. Not all the reasons for the low K are clear, but a major one appears to be the soil's high iron oxide content—more than 6 percent free iron oxides. That is why the soil is red. These compounds are known to bind soil particles together and can reduce a soil's erodibility. Iron oxides are not currently considered in the calculation of K values for soils, but these data indicate that they may be a useful factor to include.

Soil loss from the bare, tilled plots is, on the average, 75 times greater than soil loss from plots under natural grass cover. During four out of five years, essentially no soil was lost from the covered plots, illustrating the value of soil cover as an erosion control practice.

To provide "standard" conditions, these plots were situated on gently sloping land when compared with much of the rangeland in the foothills. These data illustrate that this soil is not highly erodible and that under good grass cover little erosion occurs. Steeper slopes will produce far greater soil loss from bare soils.

Proper range management can prevent large erosion losses by ensuring that an adequate plant cover exists during the rainy season. This means that grazing pressure must be controlled and that type conversion practices such as mechanical brush removal, burning, and cultivation need to be timed so that the soil is not bare during the rainy (high R) periods of the year. Further research is needed to quantify the relationship between soil chemical properties and erodibility.

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Precipitation and Soil Loss for the Auburn Soil at Sierra Foothill Range Field Station, 1975-79

	Precipitation		R†		Soil loss (A): Bare		Soil loss (A): Covered		K‡	
Year*	Metric	English	English	Metric	English	Metric	English	Metric	English	Metric
	mm	*inches*			*tons/a*	*t/ha*	*tons/a*	*t/ha*		
1975	624	24.6	58	101	1.8	4.0	<0.01	<0.02	0.03	0.04
1976	389	15.3	14	24	0.04	0.09	<0.01	<0.02	<0.01	<0.01
1977	312	12.3	11	19	0.02	0.04	<0.01	<0.02	<0.01	<0.01
1978	1,090	42.9	73	127	2.4	5.4	.07	.16	0.03	0.04
1979	754	29.7	38	66	3.4	7.6	0	0	0.09	0.12
Average	634	25.0	39	67	1.5	3.4	0.02	0.04	0.03	0.04

*Each year was a rainfall year from July 1 to June 30 except for 1975, the first year of the study, which includes data for December 15, 1974, through June 30, 1975.
†R is a measure of a storm's ability to erode soil (erosivity), combining rainfall amount and intensity, reflecting its kinetic energy.
‡K is a measure of the erodibility of a soil as governed by its own properties.