CHAPTER 6

Soil Erosion

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The erosion of soil by water should be an important consideration for anyone growing grapes on sloping land. Soil erosion is detrimental to the vines due to the loss of nutrients and rooting depth, and gully erosion can be costly to repair. Also, the washed-away sediment pollutes streams, rivers, and estuaries and increases the flooding potential downstream. Local governments in several areas of California have implemented strict erosion control programs for grape growers, especially as wooded hillsides have increasingly been converted to vineyards.

The Nature and Causes of Soil Erosion

There are three mechanisms of erosion on hillside vineyards: sheet, rill, and gully (USDA Soil Conservation Service 1975). With sheet erosion, raindrops break the bonds between soil particles and splash them a short distance. These particles are then much more vulnerable to erosion by water flowing over the surface. When rain falls faster than the soil can absorb it, water begins to collect and flow over the ground surface. Sheet erosion begins when this surface water carries particles that were detached by raindrop impact. Rills are small but well-defined channels that are only a few inches deep. They are caused by surface runoff where water begins to concentrate. The energy of this concentrated flow is able to detach and transport soil particles (fig. 6-1). Gully erosion occurs during intense rainfall on saturated soils or when rills merge together into larger channels (fig. 6-2). The major difference between gully and rill erosion is size. Gullies are too large to be repaired with normal tillage equipment and will require special treatment for stabilization.

Although the most erosive soils are those with poor aggregation (low humus content) and a high percentage of silt and very fine sand, several factors determine the erodibility of a soil. In 1965 the Universal Soil Loss Equation was proposed for estimating sheet and rill erosion sediment losses from cultivated fields in the United States east of the Rocky Mountains (Donahue et al. 1983). The equation has since been adapted for use in other cultivated areas of the United States and in many other countries. The expected soil loss is determined

Figure 6-1. Sheet and rill erosion on a new vineyard causing excessive loss of topsoil. Control of sheet and rill erosion can be accomplished by using cover crops as well as proper timing of vineyard management development.

Figure 6-2. Gully erosion on a new vineyard. Gullies are controlled by water diversions, hillside benches, and proper vineyard layout.

from the product of several factors, with lower numbers indicating less potential for erosion. The factors are rainfall, erodibility of the selected soil, length and steepness (gradient) of the ground slope, vegetative cover and management, and erosion practices used, such as terracing and contouring. For example, the presence of weeds and broadleaf plants among forest trees is predicted to reduce the "vegetative cover" factor by half compared to trees with no ground cover (Wischmeier and Smith 1978).

How Cover Crops Reduce Soil Erosion

This chapter discusses the use of cover crops to reduce soil erosion on hillside vineyards. Cover cropping is only one of many erosion control practices that should be used on steep hillside vineyards; for information on other practices, consult *Vineyard Management Practices* (Southern Sonoma County Resource Conservation District 1993).

Vegetative cover plays a vital role in controlling erosion as it:

- Shields the soil surface from the impact of falling raindrops
- Holds soil particles in place
- Prevents crust formation
- Improves the soil's capacity to absorb water
- Slows the velocity of runoff
- Removes subsurface water between storms through transpiration.

An established cover crop can provide soil protection nearly comparable to a mulch layer or other soil amendments at a lower cost. In a study conducted in a South African vineyard, a straw mulch of 3.3 tons per acre (7.4 t/ha) provided better runoff protection than a triticale cover crop, gypsum, or polyacrylamide applications (Louw and Bennie 1991). The mulch treatment resulted in a 4 percent runoff of the total rainfall. However, runoff in the cover crop treatment was only slightly higher, with the difference occurring when triticale was becoming established.

Growers should strongly consider maintaining and enhancing existing vegetative cover on areas of high erosion potential, such as erodible soils, steep slopes, bench terrace slopes, drainageways, stream banks, buffer strips, and existing or potential slips (fig. 6-3). The use of cover crops, particularly grasses, is a cost-effective means of controlling sheet and rill erosion where water flows will not exceed 5 feet (1.5 m) per second (USDA Soil Conservation Service 1984). Flows greater than this rate require engineered structures such as diversions, subsurface drainage systems, lined waterways, and bench terraces. Vegetation combined with structural measures provide optimal soil protection where the erosion potential is highest.

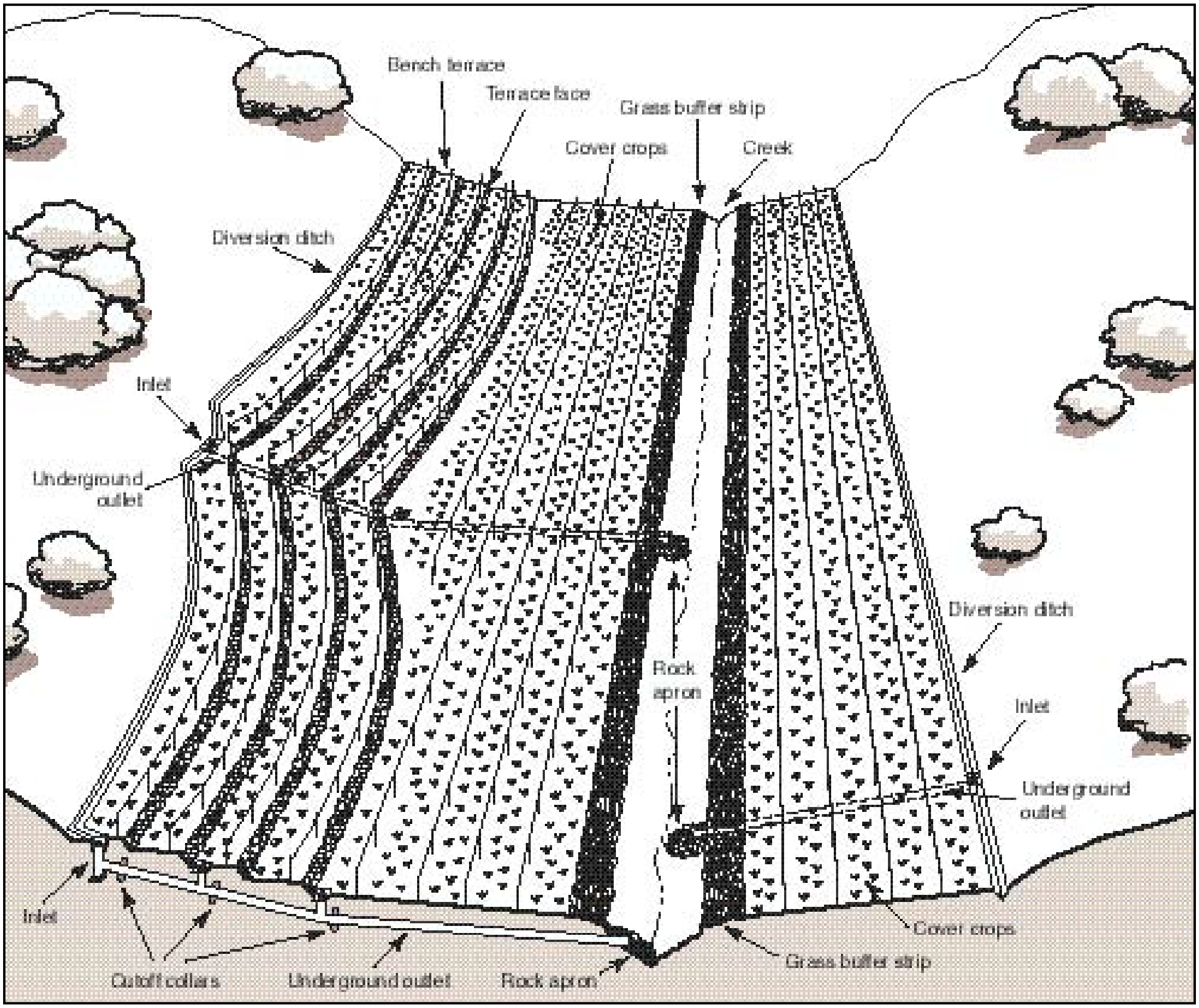

Figure 6-3. Controlling drainage in a vineyard reduces soil erosion. Diversion ditches catch water that would otherwise flow through the vineyard. The water from the diversion ditches flows to inlets and through underground outlets (pipes) and is directed to a creek. Additional inlets along the hillside help divert water from the bench terraces. Rock aprons provide armoring where the pipes drain to the creek. Grass buffer strips along both sides of the creek provide a filter for sediment. Cover crops are planted in the drive rows.

Cover Crop Selection for Erosion Control

Cover crop species and management systems are not equal in their ability to reduce erosion. Among the best cover crops for erosion control are perennial sods, which have dense foliage and root systems. Reseeding winter annual grasses, such as 'Blando' brome, also greatly enhance erosion control, but do so less than perennial sod because annual grasses begin each fall with small root systems. Reseeding winter annual legumes are often not as effective as grasses because the root systems of grasses are usually more dense. Although winter annuals that are not self-reseeding can reduce erosion once established, the disking required to plant them can cause serious erosion if heavy fall rains occur. It is also important to consider other factors when selecting a cover crop for erosion control, such as seed cost, seedling vigor, reseeding ability, water needs, and the cover crop's effects on vines, fruit yield, and quality. For maximum erosion control, the best cover would be a vigorous permanent sod that forms a dense root system, such as perennial ryegrass, tall fescue, or strawberry clover. Winter annual grasses effectively reduce erosion after they become established, and they reseed and die as vine growth begins in early spring. But the soil may be prone to erosion during heavy fall rains before young seedlings develop sufficient root structure.

Winter Annual Cover Crops

Grasses. Reseeding winter annual grasses, particularly 'Zorro' fescue and 'Blando' brome, are frequently used on hillside vineyards. They are generally well suited for erosion control because of their dense growth habit and fibrous root system. They are seeded in the fall and germinate and establish rapidly after fall rains, protecting the soil from erosion and anchoring soil particles in place. When properly managed, these species provide a self-sustaining cover crop that requires no tillage beyond the first year, although they may require replanting in some years if weeds reinvade.

Other winter annual grasses, such as cereal rye, barley, and oat, provide a protective cover crop for 1 year but generally do not produce sufficient viable seed for reestablishment in subsequent years. These species are sometimes used in new vineyards where a cover crop is desired for erosion control in the fall and winter, but where further soil disturbance is required for planting, trellising, irrigation, or other activities that will occur the following spring. Disking to smooth the surface will be warranted, after which a perennial or reseeding winter annual cover crop is planted.

Legumes. Legumes are often included in cover crop mixes to add nitrogen, provide color, or increase diversity. Established legume plants shield the soil from raindrop impact in late winter and spring. However, young legumes generally provide less protection against soil movement than young grasses because legumes have less-fibrous roots. As with grasses, some legumes reseed themselves, such as rose clover and subterranean clover. Subclover forms a dense network of low-growing stems by late winter that helps reduce soil erosion. These legumes may be added to a seed mixture with reseeding grasses (plate 2-40). Other legumes such as bell beans and field pea grow only for one season and should be planted when specific benefits are desired, such as adding more nitrogen to the soil.

Perennial Cover Crops

Most perennial grasses do not develop as rapidly as annuals but, when established, have deeper roots and provide excellent erosion control. Perennial clovers, although taprooted, also reduce erosion because of their invasive growth and their tendency to produce roots at each node. Due to the longer period needed during establishment, perennial cover crops may need to be mixed with a small amount of annual grass seed to provide adequate cover during the first year. Growers should exercise caution when using perennials because they may devigorate vines excessively.

Cover Crop Management for Erosion Control

Early establishment of cover crops is critical for successful erosion control. Early-fall planting is necessary so the seed can germinate and plants can become established with the first fall rains. With late-maturing grape cultivars, it may be best to sow the cover crop before harvest for best stand establishment. It should be noted that disking in the fall for preparation of sowing may lead to erosion if heavy rains occur in early fall. Using a no-till drill eliminates seedbed preparation and gives additional protection for erosion control, since relatively little soil surface is disturbed.

Because self-reseeding is important for erosion control, mowing of winter annuals that produce flowers above the foliage should be timed to ensure seed production and regeneration. The cover may require mowing at no less than 4 inches (10 cm) tall at budbreak in frost-prone areas, and additional mowing may be required to reduce weed competition. When flower stalks begin to push, mowing should cease in order to allow reseeding. If flowers or seedheads are mowed for frost protection before they mature, the cover crop may need to be reseeded the next fall if no further seedheads are produced. It may also be necessary to reseed whenever cover crop regeneration is sparse.

Limit mowing perennial grasses the first year to promote adequate plant growth and reseeding. However, if seed of a tall annual grass was sown along with the perennial grass, mowing will be required by late winter to enhance the development of the perennial grass. If weeds are a problem, mow in early spring to reduce shading and competition for perennial seedlings. Thereafter, 1 or 2 mowings a year at no less than 4 inches (10 cm) tall may be all that is needed. Species such as sheep fescue may not require mowing because of their short, compact growth, while species such as tall fescue may require more frequent mowing. After a good stand is established, long-lived perennial cover crops may be mowed throughout the season without regard to seed production because they do not rely on reseeding to persist. However, short-lived perennials, such as many native grass species, should be allowed to reseed in order to maintain a healthy stand.

Hydroseeding

Hydroseeding is the application of seed, fertilizer, wood fiber, and water as a sprayed slurry. In contrast to cover crop seeding methods discussed in chapter 3, establishment of vegetation by hydroseeding is generally limited to highly erodible soils such as roadcuts or terrace slopes.

The hydroseeder must be equipped with a built-in continuous agitation system sufficient to produce a homogeneous slurry of seed, wood fiber, and fertilizer in the designated proportions. The slurry should provide a uniform cover and be applied at a rate that is nonerosive and minimizes runoff. When slopes are steep or time is short, hydroseeded materials can be incorporated into the top ¼ to ½ inch (6.5 to 12.5 mm) of soil by harrowing, raking or ring rolling, or the hydroseed can be covered with a hydromulch (see Southern Sonoma County Resource Conservation District 1993). Hydroseeding gives good results when completed by October.

Use of Mulches for Erosion Control

Mulch can be used alone or in conjunction with cover crops to provide soil protection until a vegetative cover is established. To mulch means to apply a nonerosive material over bare soil or seeded areas in order to protect the soil from direct effects of rainfall, slow surface flows, reduce erosion, and provide a favorable environment for revegetation.

Straw Mulch

Straw is the most common mulch used on slopes that have been seeded and are subject to erosion. It requires anchoring by crimping or punching, spraying with a tackifier, or covering with netting. Straw mulch may be broadcast to a uniform depth of 2 to 3 inches (5 to 7.5 cm). The straw should be applied in such a manner that 80 to 100 percent of the ground surface is covered. Application rate is 2 tons per acre (4.5 t/ha). Straw mulch must be anchored by one of the following methods (Southern Sonoma County Resource Conservation District 1993).

Hand punching. Hand punching may be used on small sites or on sites with rock on the surface. A spade or shovel is used to punch the straw into the slope until all areas have stems standing perpendicular to the slope and embedded at least 4 inches (10 cm) into the slope. The bunches of straw should resemble the tufts of a toothbrush.

Roller punching. A roller equipped with straight studs not less than 6 inches (15 cm) long, from 4 to 6 inches (10 to 15 cm) wide, and approximately ⅞ inch (22 mm) thick, will best accomplish the desired effect on large sites. Studs should stand approximately 8 inches (20.5 cm) apart and should be staggered. All corners should be rounded to prevent the straw from withdrawing from the soil.

Crimper punching. Specially designed straw crimping rollers are available for use wherever roller punching can be used. These crimpers consist of serrated disk blades set 4 to 6 inches (10 to 15 cm) apart that force straw mulch into the soil. Where feasible, such as on a field cleared for a new vineyard or replanting, crimping should be done in two directions with the final pass conducted across the slope rather than up and down the slope.

Tacking agent. A tacking agent can be used in lieu of punching. It is sprayed on the straw mulch to bind the straw together so it will not blow or wash away. There are a number of tackifying materials on the market, and they can be used on any type of site.

Netting. Netting is used on steep areas where straw mulch cannot be anchored (usually slopes greater than 3 to 1). Suitable for bench terrace faces, netting is applied over unpunched straw and anchored using staples or anchor pins. The square mesh opening should be no larger than 1 inch by 1 inch (2.5 cm by 2.5 cm). Anchor pins must be rigid heavy galvanized wire that is ⅛ inch (3 mm) in diameter with a minimum length of 10 inches (25 cm). Staples must be U shaped and made of wire 3⁄32 inch (2.4 mm) in diameter or greater, and they must have legs at least 6 inches (15 cm) in length with a 1-inch (2.5-cm) crown. Placement and spacing of staples or anchor pins must follow the recommendations of the netting manufacturer.

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