



Grass in furrows help to slow down the flow of water and capture eroded soil.

For additional information, copies of this guide, or to schedule a visit, please contact:

Santa Cruz County Resource Conservation District/Capitola NRCS
820 Bay Avenue, Suite 107
Capitola, CA 95010
(831) 464-2950 OR

Resource Conservation District of Monterey County/Salinas NRCS
744 LaGuardia Street
Salinas, CA 93905
(831) 424-1036 ext. 3

Other services we provide:

- *advise & alternatives for runoff management
- *how and where to use grass and other vegetation
- *advise & alternatives for erosion control
- *advise & alternatives for wildlife habitat
- *advise & alternatives for watershed protection

Funds for this guide are provided by the California Department of Conservation.

USDA is an equal opportunity provider and employer.

Furrow Alignment:

A tool for reducing soil erosion, runoff, and improving irrigation on hillside agriculture



A How-To Guide for Growers

*By the Resource Conservation Districts of Santa Cruz and Monterey Counties
in cooperation with
USDA Natural Resources Conservation Service*

Benefits of well done furrow alignment

1. More uniform irrigation
2. More uniform drip fumigation
3. Less ponding of water in furrows
4. Professional looking fields
5. Ease of picking
6. Fewer erosion control expenses

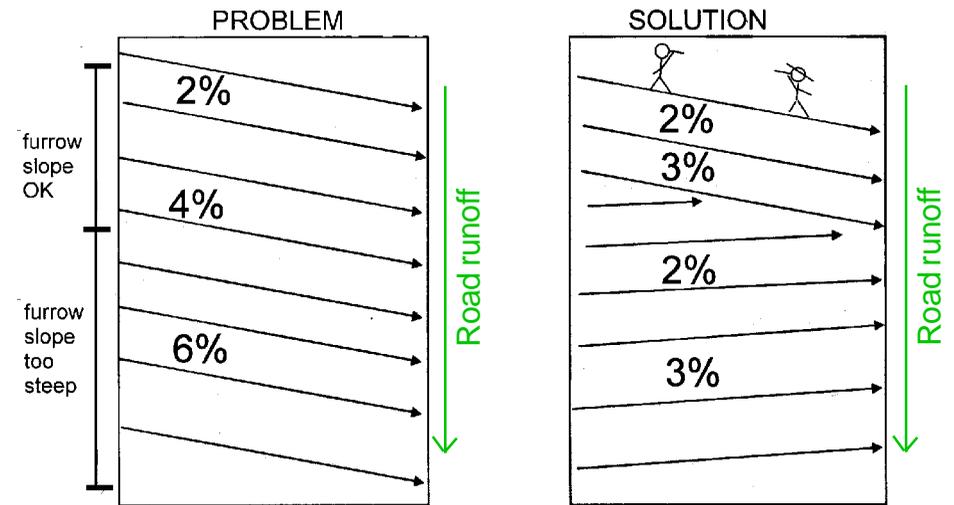


Proper furrow alignment prevents erosion and allows for easy access to the fields in the spring.

Difficult Fields

Problem: The slope of the block changes so that the furrows become too steep.

Solution: Add point rows or *cuchillas* to compensate.



irrigation and storm water flows down the furrows in the direction of the arrows

Finishing off the ends

Plant barley in the last ten feet of the furrow and around the furrow ends. This helps to protect your crop and the soil from erosion. You can also add a small bunch of barley every 20 to 40 feet along steep furrows.



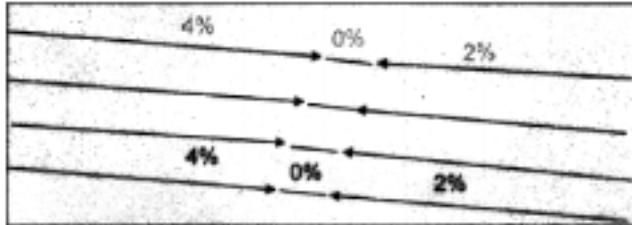
Barley in and around the ends of the furrows.

Problems and solutions

Some blocks are difficult to work with for furrow alignment.

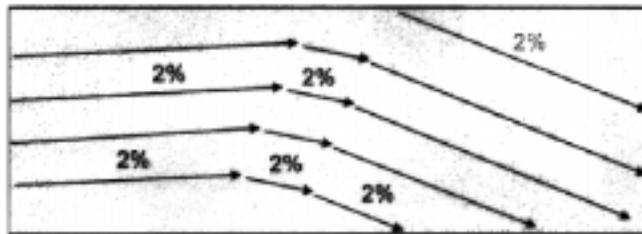
Problem:

Some fields have a low spot in them that collects water.



Solution 1:

Curve the furrow to drain the low area. Curved furrows may help eliminate low spots where water collects.



Solution 2:

Divide the block in two by putting a road through the low spot.

Solution 3:

Use land leveling to fill low area of block and eliminate ponding.



Photo of curved furrows.

Costs of poorly arranged furrows

1. Less uniform irrigation means over watering some plants and under watering others.
2. Less uniform drip fumigation increases pesticide expenses.
3. Crop loss from eroded beds.
4. Top soil and fertility loss from erosion.
5. More difficult tractor and picking access.
6. Greater runoff onto roadways can cause gullies.

Where does all that water come from?

When the sandy hills in our region are fully vegetated, almost all rainfall soaks into the soil. Bare soil and plastic mulch prevent water from seeping into the soil. Steep furrows lead to faster runoff and soil erosion.

Stop the problem before it starts!

Gently sloped furrows help the water to soak into the soil. The water that leaves the field flows slowly, leaving the soil in place.

The purpose of this brochure.

The purpose of this brochure is to provide an introduction to furrow alignment as a tool to manage cropland for optimum productivity and minimal environmental impact. Furrow arrangement is a technique that requires practice and experience to master, and for some parcels it can be difficult to achieve low slope furrows throughout the block. Modify these methods as needed to best fit the land you farm and your own methods of listing beds.

Operating heavy equipment across steep slopes can be dangerous. Know the limits of your equipment. Safety first.

We encourage you to contact your local Resource Conservation District (RCD) or USDA Natural Resources Conservation Service (NRCS) if you would like a hand laying out your own fields. The RCD and NRCS disclaim any damage to property that results from the improper or partial implementation of the techniques presented in this brochure.

How steep is too steep?

The goal in furrow alignment is to make the furrows as close to level as possible without causing water to pond in the furrow. A good target to shoot for is 1.5% to 2% furrows. Avoid furrows steeper than 4% or 5%.



Photo of steep furrows. Note furrow erosion accumulating at the base of hill.

How flat is too flat?

Flat furrows are not a problem unless water collects in them which can damage beds or crops. Give the water a way out.

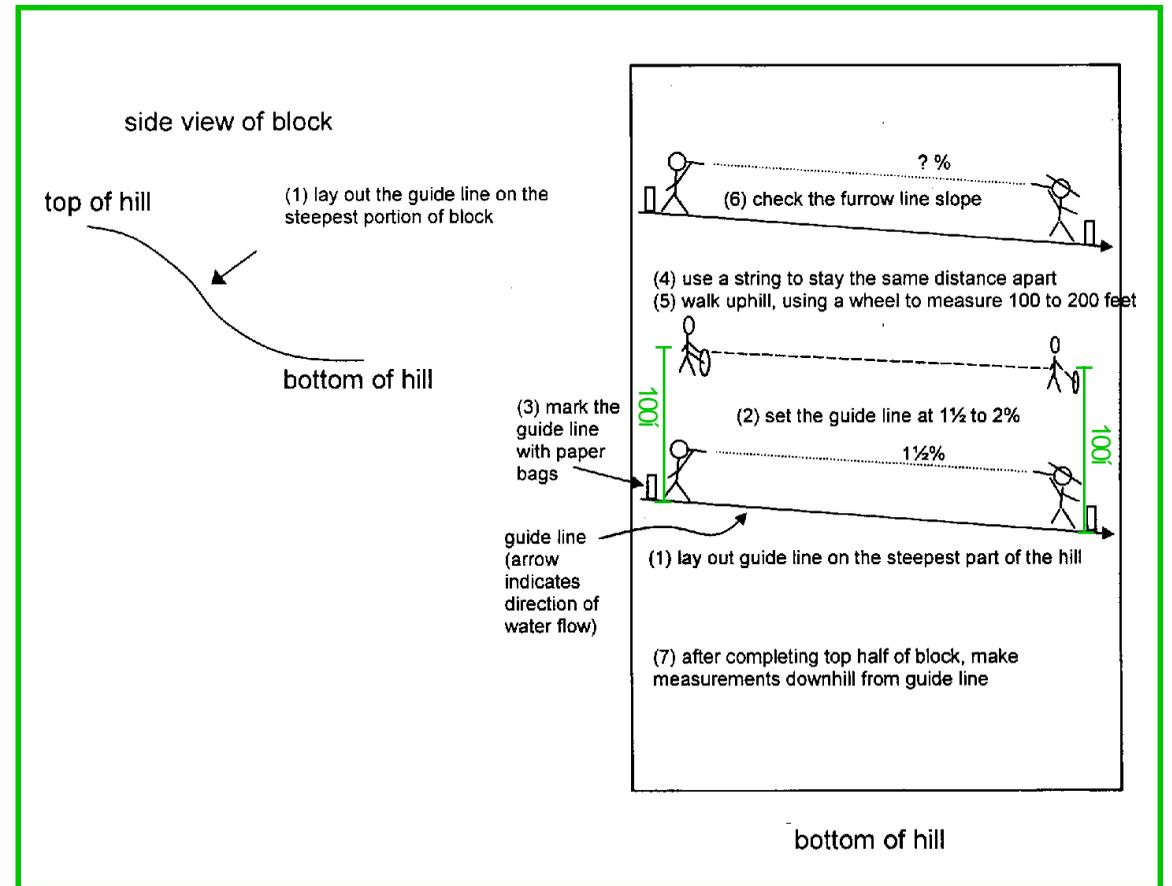
OK: road
Water drains from furrow.

(This is a side view of furrow that drains well)

NOT OK: road
Water flows to center of furrow.

(side view of furrow that ponds water)

Laying out the guide lines



Steps for furrow alignment

Block layout and planning:

- 1 Place roads in the highest and lowest parts of the field.
2. Leave areas that carry substantial water in natural vegetation.
3. Do not direct water to roads that cannot handle it. Plant all roads heavily with erosion control grasses such as fescue, rye, or barley.
4. Direct water away from heavily traveled roads, or direct traffic away from roads that cannot be kept dry.

Lay out the guide line:

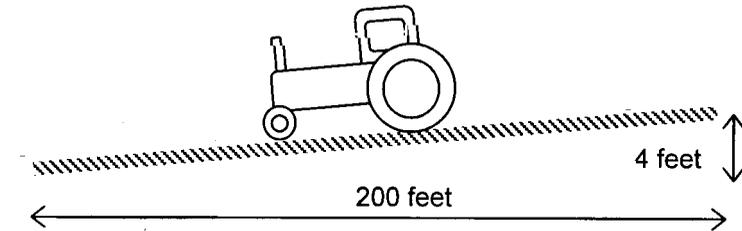
- 1 The guide line marks the alignment of the furrows for the entire block.
2. Go to the largest, most difficult part of the block to lay out the guide line (see page 8).
3. Set out a 1.5% to 2% line using an instrument for measuring slope.
4. Mark the guide line with paper bags or stakes.

Copy the guide line both up and down the block to mark furrow lines:

- 1 One person stands at each bag or stake, holding a string tightly between them.
2. Each person uses a measuring wheel or tape to walk 100' or 200' uphill to the next place where the furrow slope is to be checked. The distance will be determined by how complicated the slope of the block is. As they walk at the same speed, the string between them remains taught, which helps them stay the same distance apart.
3. Check the slope of the new furrow line. If the furrow line is less than 4% and has no low points that will pond, then mark the line and continue to move uphill and lay out furrow lines until the top half of the block is complete.
4. Go back to the guide line and measure downhill to lay out additional furrow lines. If any of the furrow lines are steeper than 4% or have low points that will pond, then go back to guide line, adjust it, and repeat steps 1 through 4.
5. If the furrows in the block cannot be arranged so that all are less than 4%, align the furrows so that the steepest ones are at the bottom of the block, where the fast flowing water will do the least amount of damage.

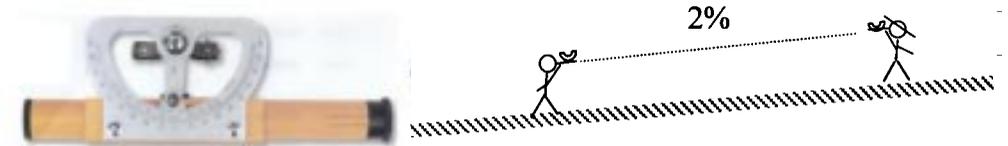
Tools of the trade

What is a 2% slope? $4 \text{ foot rise} / 200 \text{ foot run} = 4/200 = 2/100 = 2\%$

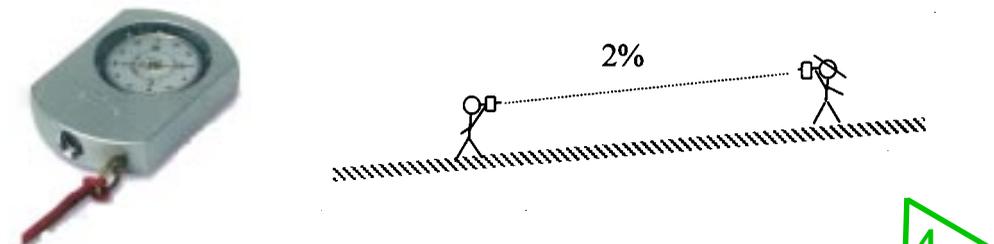


Instruments that measure slope and how to use them:

Abney Level: An abney level measures slope. Look through the level and aim at an object that is the same height as your eye. For example, if you are one inch taller than your partner, aim at the brim of their hat. Now adjust the abney level until the level bubble is in the center of the view. Then read the percent slope off the side of the instrument.



Clinometer: A clinometer measures slope. Hold the clinometer up to one eye, while keeping both eyes open. With one eye, look at an object that is the same height as your eye. With the other eye, look at the clinometer dial to read the slope in percent. Percent numbers are on the right hand side as you read the clinometer.



Tools of the trade (continued)

Hand Level: Looking through a hand level, you see objects at the same elevation as your eye when the bubble is centered. This method can be used by one person alone by pounding a stake into the ground and tying a ribbon to it. You must make the needed measurements to calculate the slope.

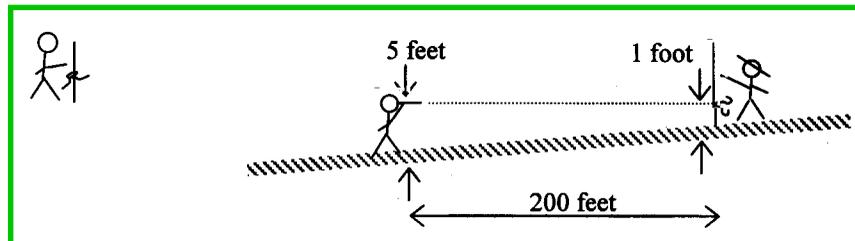


In the sketch below, the user's eye is five feet above the ground. He sights 200 feet across the field to a pole held by a partner. The pole has a ribbon tied to it one foot above the ground. The slope can be found by calculating the rise over the run:

The rise is: 5 feet - 1 foot = 4 feet

The run is: 200 feet

The slope is: $4 \text{ feet} / 200 \text{ feet} = 4/200 = 2/100 = 2\%$



Tools used by professional surveyors

Auto Level:

Tripod mounted instrument that works like a hand level, but with greater accuracy.

Total Station:

Tripod mounted instrument that uses a light beam to measure distances and an internal level to measure slope.

Global Positioning System Receiver:

Backpack or handheld instrument that uses satellite signals to determine the elevation and position of the receiver.

Tips

1. Make a map of the field and the furrow line slope measurements as you take them. This map will help you make decisions about how to lay out the furrows and adjust the guide line for best results.
2. If there is no way to avoid a few steep furrows, align the furrows so that the steepest ones are at the bottom of the block, where the fast flowing water will do the least amount of damage to the roads.
3. Check your leveling instrument and measuring wheel frequently (once per week during regular use) to make sure it is reading correctly.
4. If you find low spots in your field that collect water, drain them with one inch PVC pipes to a furrow that will carry water out to a road.
5. Keep the furrow soil loose so the rain water soaks in. Avoid operating heavy equipment on the soil, especially when it is wet. Consider chiseling the furrows to increase infiltration.