

CONTOUR FARMING AND SOIL AND WATER CONSERVATION

A LEVELING DEVICE AND HOW TO SURVEY CONTOUR VETIVER HEDGEROWS

With changing climate and increasing demand for water the Global Hydrological Cycle (GHC) is in trouble, and is being destabilized through climate change and misuse of water. One of the causes is depleted groundwater that is not being recharged. The amount of rainwater infiltration can be improved significantly (by as much as 30%) by cultivating on the contour, and this, in turn, improves groundwater recharge, and reduces down-watershed/basin flooding. **Too many farmers do not cultivate on the contour, instead they cultivate up and down the slope or obliquely, dictated by convenience or shape of fields.** There are many instances where conservation works have been established, but often, like graded terraces, they deliberately remove water from cultivated areas to drainage areas; thus, effectively reducing annual plant water availability; and increasing short term volume and velocity of water flow in rivers. Also, sometimes supposedly contour terracing and cultivation have not been laid out correctly due to bad/inaccurate survey techniques.



Figure 1. Vetiver hedgerow on the contour (Mexico) PC: Antonio Carrillo Bolea.

To help farmers cultivate on the contour, permanent contour marker lines need to be established – vetiver grass hedgerows planted on the contour provide that permanence. Also, if correctly spaced those same hedgerows will accelerate and increase rainfall infiltration, improve groundwater recharge, reduce soil erosion, and provide other multiple benefits such as pest control, mulch, thatch, and forage.

Contour lines need to be surveyed and pegged before the marker lines (vetiver hedgerows) can be planted. Large commercial farmers can afford to hire professional surveyors to do this work, but they can be expensive, and anyway most farmers, given a simple survey instrument, with a day's training, could do it themselves. Expensive survey instruments are not required. Many contour lines are laid out using "A" frames (Figure 2). These are good when used properly, but they are slow and cumbersome and best used for small jobs.

Also, Vetiver can be planted on an average contour (straighten it out a bit and making cultivation easier). In figure 3, A is the actual contour and B is the average contour along which a Vetiver hedgerow can be planted. Low spots on the "average contour" will eventually fill with sediment behind the hedge and become "level".



Figure 2. "A" Frame level

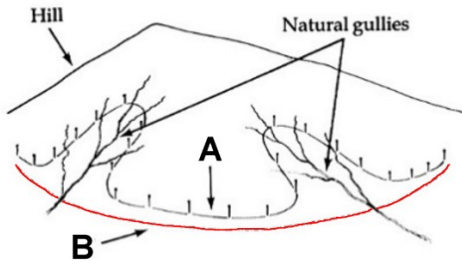


Figure 3. Actual contour (A) and average contour (B)

(30m?), as well as being easy to use and carry.

There are more sophisticated devices such as transit and laser levels – very accurate but expensive, and not really needed for establishing vetiver hedgerows on the contour – this is particularly so, because normally vetiver hedgerows do not have to be aligned on an exact contour but can be averaged out.

The following paragraphs describe an improved “water tube” levelling system that can measure sufficiently accurately over much longer distances

LEVELLING DEVICE FOR ESTABLISHING AND PEGGING CONTOUR LINES FOR VETIVER HEDGEROWS

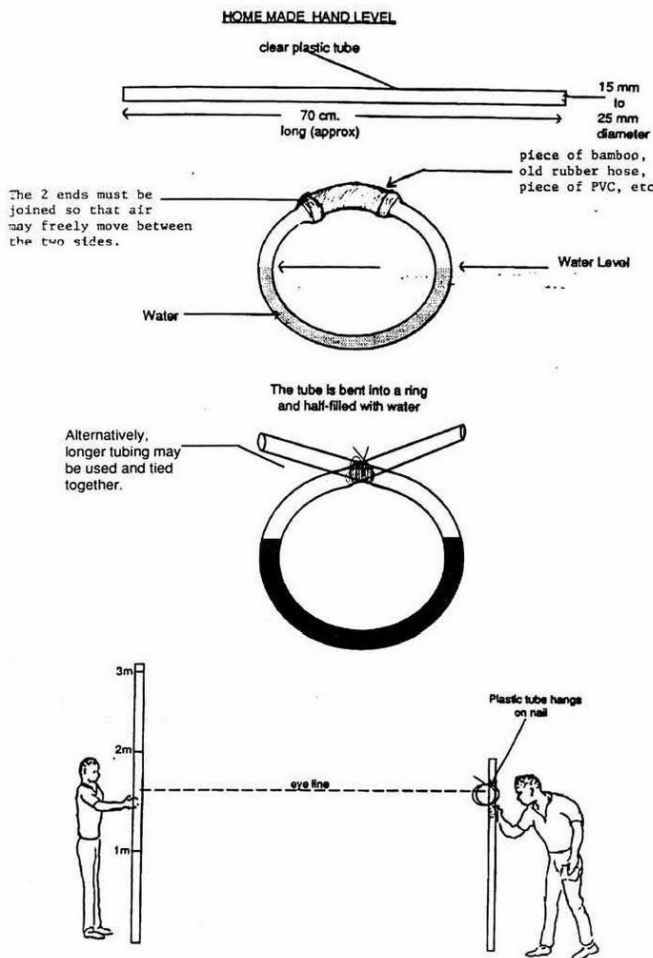


Figure 3 The older version sighting level

Mark 1 Water level ... This is the original circular water tube level from the 1990s used in Malawi for surveying contours for vetiver hedgerows. I always found that hanging the tube on a nail and sighting the water level was a bit “wobbly” and not that easy to “sight”.

It is certainly faster to use than an “A” frame and you can sight over longer distances.

I have been thinking how we can “tweak” the design for improvements and came up with the following design which I think should work very well. I believe you should be able to “sight” 30 meters (100 ft) or more distances with the modified design and set up. The principles of use are basically the same.

Mark 2 water level. This is the new version of the level, together with a simple but accurate sighting stick (rod).

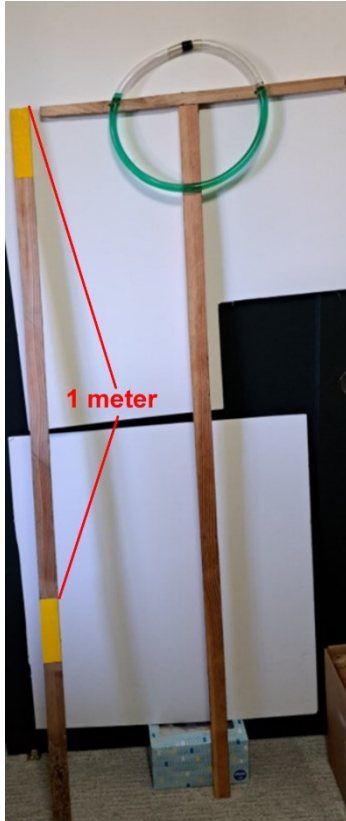


Figure 4 New version sighting level with sighting pole/rod

The new version, as shown in Figure 4, provides (a) for a fixed height and steady post for the level to be placed on, and a horizontal wooden “sight” to which is attached the circular sighting bubble in a fixed and permanent position; and (b) a “sighting rod” at exactly the same height as the sighting level with two well marked color segment, the first at the top and the second 1 meter below the top. This pair of “instruments” is very easy to make.

How to make Mark “2” level

STEP 1. Make a circular tube about 30 cm (12 inches) in diameter. Use a length of clear plastic tubing of about 25 mm (1/2 inch) inside diameter, and 90 cm (3 ft) long. Join the ends together by inserting a short length (50 mm. or 2 inches) of 9.5 mm (3/8 inch) diameter tube. Wrap a piece of tape around the tube where the two ends meet. Prior to joining the tube , add liquid so that it is about 1/2 to 2/3 full. A colored fluid such as tea or coffee, or motor oil instead of water, makes it easier to use (I used windscreen wiper fluid in Figure 4 example.

STEP 2. Make the sighting post. Cut a pole (bamboo, sawn timber) with a cross section of about 2.5 x 2.5 cm (1 x 1inch) square to a length that is an inch or so lower than the users eye level when standing. Then cut another piece of wood with the same cross section that is 30 cm (24 inches long),and attach it at 90° centered to the top of the pole with a couple of screws or nails – as in Figure 4. This horizontal piece of wood will be used for “sighting” and is called the “**SIGHT**”.

STEP 3 Make the sighting pole/rod. This can be made of any pole material (wood, bamboo, pvc pipe). It should be cut to exactly the same height as the sighting post, including the height of the 30 cm “sighting” piece. Paint or tape the top 15 cm (6 inches) in some bright color (in this case yellow -- red is probably better). Then measure exactly 1 meter (39.3 inches) from the top of the pole and paint another color band. The top of this lower band must be 1 meter from the top of the pole (as in Figure 4).

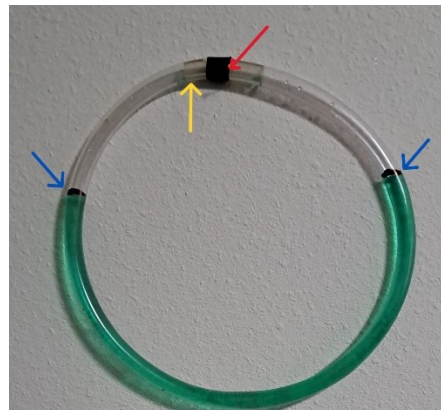


Figure 5. Marking the water levels.

STEP 4 Marking the water level on the circular tube.

The water levels on the circular tube should be marked accurately. The easiest way is to hang it from a nail on a wall – red arrow (with the tube joined at the top – yellow arrow) and mark the tube with a marker pen at the top of the two water levels (located on opposite sides of the tube) – blue arrows.

STEP 5. Attach circular tube to cross piece "SIGHT". First, attach the tube with wire or string (wire is better because it will tighten better) so that the two marks on the tube coincide with the upper edge of the "sight" as in Figure 6.



Figure 6 Attaching the circular tube to the "sight".

It needs to be fixed tightly so that the tube will NOT move from the position. The marks must be accurately aligned to the sight upper edge to assure proper levelling of the sight. Now when looking along the "sight", in the direction of the orange arrow, the "sight" will be level when the water is level with the upper edge

of the "sight". At this point the "sight" can be used as a level. However we want it to be steady and at the right height and that is why the post (step 2 above) is added

How to use – Part 1. Surveying a level contour. The surveyor (person using the level) stands at the start of a proposed contour vetiver hedgerow line. Have your helper (known as the "rod man") move to say a position 10 meters or more away on the approximate contour. The rod man holds the rod in a vertical



Figure 8 Surveyor will look along the cross piece (sight) and have the rod man move so that it is in line with the top of the cross piece.

position. The surveyor then first tilts (pivots) the "sight" up or down until the water level in the tube matches the top edge of the sight. At that point the "sight" is level. (Note: Figure 8) and should be pointing along an approximate "eyeballed" contour. The surveyor, now with a level "sight", sights down the "sight", and instructs the rod man to move up and down the slope until, Figure 9, top of the rod is level with the sight level. Note: the surveyor will need to rotate his level "sight" to match the position of the rod man. (in this case the top of the yellow mark at the top of the pole). This is the point where the surveyor and rod man are at the same level. Pegs are put in the ground at these two positions. The surveyor moves to the second peg (where the rodman



Figure 9. Looking down the sight piece with the top of water level matching top of sight. The sighting rod in the background with top level with top of sight

had just been) and repeats the process again and again until the end of the proposed contour hedge is reached (Figure 10)

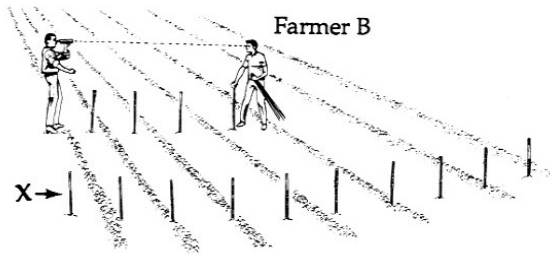


Figure 10 . Surveying and pegging a contour line using a handheld "sighting" level.

How to use – Part2. Locating the next contour up the slope.

Vetiver hedgerows are normally located at 1 or 2 m vertically apart. This is called the Vertical Interval (VI). (see Figure 11 below). To find the position of the next contour up the slope at 1m VI the surveyor stands next to the start peg of contour #1, sets up his sighting level as in Step 5 and points up the slope.

Then in **this case the surveyor needs to take a level sight at the top of the lower yellow (1m) mark on the**

rod. That will be the point where the second contour is 1m higher than the first contour. If the need is for the more standard 2m VI the surveyor will need to move to the 1m VI spot and take a second reading up slope in order to find and locate the 2m VI. Once the appropriate VI has been determined and located, a new level contour can then be surveyed.

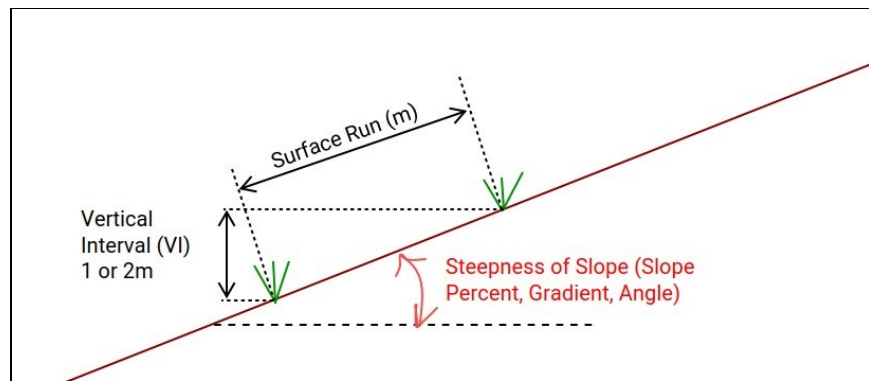


Figure 11 Vertical interval and surface run

The attached table shows the different surface distances that should result from contours at 1m and 2m VI for different slopes.

Table 1: Gradient and VI conversions

Slope percent	Gradient	Surface Run meters at 1m VI	Surface Run meters at 2m VI	Slope percent	Gradient	Surface Run meters at 1m VI	Surface Run meters at 2m VI
1.7	1 " 57.3	57.3	114.6	44.5	1 " 2.3	2.5	5
3.5	1 " 28.6	28.7	57.4	46.6	1 " 2.1	2.4	4.8
5.3	1 " 19.1	19.1	38.2	48.8	1 " 2.0	2.3	4.6
7	1 " 14.3	14.3	28.6	51	1 " 2.0	2.2	4.4
8.8	1 " 11.4	11.5	23	53.2	1 " 1.9	2.1	4.2
10.5	1 " 9.5	9.6	19.2	55.4	1 " 1.8	2.1	4.2
12.3	1 " 8.1	8.2	16.4	57.7	1 " 1.7	2	4

Slope percent	Gradient	Surface Run meters at 1m VI	Surface Run meters at 2m VI		Slope percent	Gradient	Surface Run meters at 1m VI	Surface Run meters at 2m VI
14	1 " 7.1	7.2	14.4		60.1	1 " 1.7	2	4
16	1 " 6.3	6.4	12.8		62.5	1 " 1.6	1.9	3.8
17.6	1 " 5.7	5.8	11.6		65	1 " 1.5	1.8	3.6
19.4	1 " 5.1	5.2	10.4		67.5	1 " 1.5	1.8	3.6
21.3	1 " 4.7	4.8	9.6		70	1 " 1.4	1.7	3.4
23.1	1 " 4.3	4.5	9		72.7	1 " 1.4	1.7	3.4
25	1 " 4.0	4.1	8.2		75.4	1 " 1.3	1.7	3.4
27	1 " 3.7	4	8		78.1	1 " 1.3	1.6	3.2
28.7	1 " 3.5	3.6	7.2		80.1	1 " 1.2	1.6	3.2
30.6	1 " 3.3	3.4	6.8		84	1 " 1.2	1.6	3.2
32.5	1 " 3.1	3.2	6.4		87	1 " 1.2	1.5	3
34.4	1 " 3.0	3.1	6.2		90	1 " 1.1	1.5	3
36.4	1 " 2.8	3	6		93	1 " 1.1	1.5	3
38.4	1 " 2.6	2.8	5.6		96.6	1 " 1.0	1.4	2.8
40.4	1 " 2.5	2.7	5.4		100	1 " 1.0	1.4	2.8
42.5	1 " 2.4	2.6	5.2					

Handheld Sight – Another simple levelling device is this Johnson hand level (available on Amazon) that



Figure 12: Hand Sighting Level (PC. Amazon.com)

can be carried in one's pocket. If you use this level, I suggest that you make a "sighting rod" as shown for the Mark 2 water level above, and another – sighting post -- (at the same length + ½" to match the sighting line in this level) to rest the level on – thus assuring that the level and the sighting rod marks match correctly. There are other hand sighting levels that cost more.

Acknowledgements: I would like to thank Jim Smyle (landscape conservationist and CEO TVNI), Lily Grimshaw (geo-engineer), Glenn Allison (agriculturist from Africa) who introduced me to the Mark 1 model level described in this document, and my vetiver friends around the world who hopefully will use it!

Dick Grimshaw November 2023