

Notes on the Anno Agro Industry Farm vetiver paper, read alongside Gibe Kabala

An internal review note · September 2026

Paper reviewed: Abdisa Gesesse, Tesfaye Balemi, P. Natarajan and Yosef Amha (2013). Effect of vetiver grass hedges in maintaining soil fertility and productivity at Anno Agro Industry Farm, Gobu Sayo District, Oromia Region, Ethiopia. *Journal of Science and Sustainable Development* 1(1): 37–49, Ambo University.

Read against: TVNI, *Notes on the Gibe Kabala vetiver hedgerow demonstration* (September 2026), and the Gibe Kabala paper it reviews.

1. Why read the two together

The two papers are close to mirror images, and each supplies what the other is missing.

Gibe Kabala is young, large and participatory: two seasons, 33.5 hectares, sixty smallholders, field yields, and no statistics. Its central weakness, as our note on it sets out, is that the yield result cannot be separated from the attention the farmers received. Anno is old, small in sampling terms and commercial: hedges established from 1995 and sampled after more than fifteen years, on a farm that adopted vetiver on its own account, with stated laboratory methods, significance tests, and a pot trial that removes field management from the comparison altogether. Its weakness is the reverse: it says nothing about field yield, and nothing about the mechanisms that only operate in the field.

Read side by side, the two give a first, rough picture of how the soil under a vetiver system changes between year two and year sixteen. They also sharpen two of the questions we raised with the Gibe Kabala team, on soil carbon and on cation exchange capacity, and they suggest the cheapest experiment we know of for testing the mycorrhizal question.

2. What Anno adds that Gibe Kabala lacks

Maturity. Anno is the only Ethiopian dataset we know of that measures soil under vetiver hedges more than a decade old. The Gibe Kabala changes are two-season changes; Anno shows where such a system may be heading.

Self-adoption. The paper records that the farm's investors chose vetiver because terraces were expensive, took cropping space, and on steeper ground were destroyed by runoff. No project paid for the planting. For a policy audience that is a different and in some ways stronger kind of evidence than any demonstration: a commercial enterprise, spending its own money, preferred the hedge to the terrace and kept it. Satellite imagery dated 14 January 2025 shows the hedges still intact, about thirty years after planting began (section 8).

Methods stated. Available phosphorus is Olsen, organic matter is Walkley–Black, CEC is ammonium acetate, total nitrogen is Kjeldahl. These are precisely the details we asked the Gibe Kabala authors to supply.

Statistics. Differences are tested (Tukey, $\alpha = 0.05$) and P values are reported. As section 5 explains, the tests are on the wrong unit of replication, but the paper at least makes the attempt.

Management removed. The pot trial grows maize in soil from the two areas under identical greenhouse conditions. Whatever it shows cannot be due to farmer selection, training, visits or inputs in the season of measurement, which is exactly the confound (mechanism (e) in our Gibe note) that the Gibe Kabala design could not exclude.

3. The carbon benchmark

This is the most useful thing the Anno paper does for the Gibe Kabala discussion, and it is not something either set of authors pointed out.

Anno reports organic matter, not organic carbon. Converting with the conventional Walkley–Black factor of 1.724, the unprotected soil at Anno carries 1.57% organic carbon. That is the same figure, to two decimal places, as the Gibe Kabala baseline. The protected soil at Anno carries 2.49%. Gibe Kabala reports 2.28% after two seasons.

	Anno, no vetiver	Anno, vetiver	Gibe, before	Gibe, after
Organic carbon (%)	1.57*	2.49*	1.57	2.28
Sampling depth	0–30 cm	0–30 cm	0–20 cm	0–20 cm
Time under vetiver	none	about 16 years	none	two seasons
Bulk density (g/cm ³)	1.39	1.29	not reported	not reported

** Derived from reported organic matter (4.3% and 2.7%) using the factor 1.724. Anno is a space-for-time comparison; Gibe Kabala is before-and-after on the same fields.*

Using Anno's own bulk densities, the protected soil holds roughly 31 t C/ha more than the unprotected soil in the top 30 cm (about 36 t C/ha on an equivalent-soil-mass basis). Spread across sixteen years, that is about 2.0 to 2.2 t C/ha/yr, or 7 to 8 t CO₂eq/ha/yr.

Set that beside the two Gibe Kabala figures. The reported annual soil sequestration, 5.82 t CO₂eq/ha/yr or about 1.6 t C/ha/yr, sits comfortably within the range that Anno's long-run difference would suggest. The measured change in organic carbon does not. On our earlier assumption of a bulk density near 1.2, the Gibe Kabala rise from 1.57% to 2.28% implies about 17 t C/ha gained in two seasons in the top 20 cm, which would be more than half of what Anno accumulated over sixteen years to a greater depth.

The simplest reading is that the Gibe Kabala reported sequestration rate is plausible and the Gibe Kabala measured soil change is not representative of the field. That points back, again, to where the post-intervention samples were taken. A sample from the deposition wedge above a young hedge would show exactly this: a large, fast change on a narrow band.

We should be careful with this in both directions. The sites differ in rainfall, cropping and soil, and Anno's comparison is between two areas rather than one area over time. Nor is Anno's difference all sequestration. Some is carbon redistributed from upslope and held behind the hedges, and some is carbon the unprotected land lost rather than carbon the protected land gained. A rate of 2 t C/ha/yr would be high for cropland, and we would not want to see it quoted as a sequestration figure. As a benchmark for judging whether a two-season change is credible, however, it is the best Ethiopian number we have.

4. What the pot trial can and cannot say about the Gibe Kabala yield gain

Our Gibe note set out five candidate mechanisms for the 67% maize gain. The Anno pot trial, by its design, switches most of them off. Soil was air-dried, sieved to 2 mm, repacked into five-liter pots and watered daily for two months.

Mechanism	In the Anno pot trial?	Why
Soil fertility and deposition	Included	This is what the trial measures: the nutrient status of the soil itself.
(a) Water redistribution below the hedge	Excluded	Daily watering, and no slope, runoff or field structure in a pot.
(b) Mycorrhizal nutrition	Possibly included, not measured	Arbuscular mycorrhizal spores generally survive air-drying and sieving, so vetiver-associated inoculum may have been carried into the pots. Nobody looked.
(c) Stem borer trapping	Excluded	Greenhouse, two months, no pest pressure recorded.
(d) Nematode suppression	Largely excluded	Air-drying kills most plant-parasitic nematodes, so any difference in field populations would not reach the pots.
(e) Management and inputs	Excluded in the season measured	Identical pot conditions. Any legacy of past fertilizer use on the two areas remains in the soil, however.
Soil physical structure	Excluded	Sieving and repacking destroy field bulk density and aggregation.

How the Anno pot trial maps onto the five candidate mechanisms in the Gibe Kabala note.

So the pot trial isolates the soil-mediated part of the vetiver effect, with a possible biological component riding along with it. The response is clear. Root dry weight is 21% higher in the vetiver soil. The paper does not give shoot dry weight numerically, but if the root-to-shoot ratios (0.56 and 0.63) are on a dry-weight basis, shoot dry weight works out at about 6.1 g against 4.5 g, a gain of roughly 36%.

This is two months of vegetative growth, not grain yield, and it cannot be translated into a yield figure. What it does show is that a substantial part of the vetiver advantage survives the removal of management, water redistribution and pests. That is the first piece of Ethiopian evidence that the Gibe Kabala yield gain is not wholly an artifact of attention, and it is worth saying so to the Gibe Kabala team. It also suggests that the field gain, where the excluded mechanisms are acting as well, should be larger than the pot gain, which is what Gibe Kabala found.

5. Problems the two papers share

Most of the reporting gaps in our Gibe note apply equally to Anno, and some are more serious at a mature site.

Sampling position

Samples were taken "in a zigzag manner" from farmland with and without vetiver. The paper does not say where the zigzag ran relative to the hedges. After sixteen years, the deposition wedge behind a hedge can be a small terrace, and the top 30 cm of it may be largely soil that came from upslope. A zigzag across the whole

inter-hedge strip and a zigzag that happened to cross several wedges would give very different answers. The gradient transect we proposed for Gibe Kabala would resolve this at Anno as well.

The likely scale of the problem is set by Ritchie (2001), who found by repeated topographic survey that recent sediment was building up at 1 to 2 cm a year upslope of a grass hedge. At anything like that rate, sixteen years would place 15 to 30 cm of deposit behind each hedge at Anno, which is the full depth sampled. If the zigzag crossed the wedges, a large share of the "with vetiver" sample may have been trapped sediment rather than soil in place. Because that deposit should be comparatively coarse (section 7), soil texture measured alongside the chemistry would identify it.

Comparability of the control

On a farm that adopted vetiver widely, land left without it is probably different for a reason: flatter, cleared later, used for another crop, or managed by another unit. The paper describes the control only as the adjacent area. Slope, cropping history and fertilizer use on both areas are needed before the difference can be attributed to vetiver. This is the space-for-time equivalent of the Gibe Kabala problem with its untreated fields.

Unit of replication

The six soil replicates appear to come from one protected area and one unprotected area, and the four pot replicates from one homogenized composite of each. The significance tests therefore establish that these two soils differ, which they plainly do, but not that vetiver caused the difference or that it would generalize across the farm. This is a common design in soil studies and not a reason to discount the work, but it should be described honestly when the paper is cited. Several paired sites across the farm, each with its own protected and unprotected area, would turn it into a genuine test.

Hedge parameters

As with Gibe Kabala, there is no hedge spacing, vertical interval, inline planting distance, number of rows, slope, cutting regime, or statement on whether hedges were planted on fresh contours or on existing bunds. At a site of this age the maintenance history and the condition of the hedges at sampling matter as well.

Depth

Anno sampled a single layer, 0–30 cm. That makes it impossible to test the subsurface phosphorus asymmetry we drew attention to in the Gibe Kabala data, where available phosphorus rose at 20–40 cm but not at 40–60 cm, although pH rose at all three depths. A sixteen-year root system should show that signature more strongly than a two-year one, if it is real. Anno is where to look.

6. Points specific to the Anno paper

Bulk density

The abstract lists bulk density among the parameters that were significantly higher with vetiver. The results show the opposite: 1.29 g/cm³ with vetiver against 1.39 without. The results are the more plausible, and the abstract appears to be in error.

More substantively, the paper explains the faster emergence and heavier roots in the vetiver soil by lower compaction and better aeration. That explanation does not survive the method. The soil was sieved to 2 mm

and repacked into pots, which erases field bulk density. Whatever caused faster emergence in the pots, it was not the field compaction difference. Nutrient status or soil biology remain candidates.

Soil moisture

The difference is 7.25% against 6.80%, measured on an unstated date. For a clay loam these are dry-season values, which is the right time to look, but a single sampling date with no season stated cannot carry the infiltration interpretation offered. February gravimetric sampling by distance from the hedge, as proposed for Gibe Kabala, would do so.

Cation exchange capacity

Anno's CEC values, 27.5 and 37.0 meq/100 g on reddish clay loams at 1,700–1,900 m, are what one would expect for soils of that kind. They make the Gibe Kabala baseline of 2.54 meq/100 g look even less likely as a real value and strengthen the case for confirming the method and units there. The Anno increase of about a third is also more in keeping with an organic matter effect than the threefold Gibe Kabala rise.

Values worth confirming

- Exchangeable potassium of 0.134 and 0.087 meq/100 g is very low for highland soils of this type, where values several times higher are more usual. A units or dilution error seems possible.
- The implied carbon-to-nitrogen ratios, about 7.8 and 6.5, are low for cultivated soils. Either figure could be right, but the combination is worth checking.
- Available phosphorus appears only in Figure 3, with no numeric values in the text. As at Gibe Kabala, the change cannot be computed from what is published.

Editorial points

- The title reads "Headges" and the abstract "vetivar"; the species name should be *Chrysopogon zizanioides*.
- The root-weight discussion says the lower root weights were in the soil with vetiver; the data show the reverse.
- Schollenberger and Simon is cited as 1945 in the text and 1994 in the references; 1945 is correct. Affiliation 1 is missing from the author list, and Truong is spelled "Troung" throughout.
- The statement that constructed structures reduce soil loss but not runoff, and can harm soil moisture, is attributed to Grimshaw (1993). The reference given for it is an entry on Francesca Bray's volume of *Science and Civilisation in China*, which does not support the point. The intended source should be identified if the paper is cited in TVNI material.

7. Nitrogen and the fine fraction

Total nitrogen at Anno is 0.32% under vetiver against 0.24% without, a difference of about a third. The paper attributes it to higher organic matter and reduced erosion. We think a third mechanism deserves attention: redistribution of the fine, nitrogen-rich fraction of runoff by sheet flow below the hedges.

The physical basis

The flume work of Meyer, Dabney and Harmon (1995) on vetiver and switchgrass hedges showed that trapping is strongly size-selective. The hedges backed water up to 400 mm deep and trapped more than 90% of sediment coarser than 125 μm , but only about 20% of material finer than 32 μm . Dabney et al. (1995) found that trapping came mainly from deposition in the ponded backwater upslope of the hedge rather than from filtration within the grass.

The implication is that what passes a hedge is overwhelmingly the fine fraction: clay, fine silt and fine organic matter. That is where soil nitrogen, phosphorus and exchange capacity are concentrated, and sediment in runoff is typically enriched in nitrogen relative to its source soil. Without hedges, this material leaves the field in rills. With hedges, it is released below each hedge as a broad sheet and spread across the strip. Over sixteen years that could add appreciably to the nitrogen of the whole inter-hedge strip, not only the wedge. It is the fertility counterpart of the water redistribution mechanism (a) in our Gibe note.

Evidence in the Anno data

The paper offers indirect support. The CEC difference, about 9.5 meq/100 g, is larger than the organic matter gain can explain; on standard assumptions a 1.6-point rise in organic matter accounts for perhaps a third of it. The remainder suggests clay enrichment, and higher exchangeable potassium, which is held on clay, fits the same picture. That is the signature one would expect if fines are being retained and spread. It is consistent with the mechanism but does not demonstrate it, because the paper measured neither texture nor sampling position.

A necessary qualification

If a single hedge catches only about a fifth of the fines, most of them are not deposited below it. They stay on the field only to the extent that the spread water infiltrates before it reaches the next hedge. The benefit therefore depends on infiltration, and on the fact that field sediment is aggregated and behaves coarser than the dispersed sediment used in flumes. At field scale this is retention rather than addition: the nitrogen spread below a hedge came from upslope of it. What the hedge changes is whether that nitrogen stays in the field and how evenly it is distributed.

The infiltration assumption needs to be held carefully. Meyer, Dabney and Kemper (2001), summarizing the US plot work, report that hedges cut soil loss substantially but reduced runoff only slightly on short, gentle plots, and a companion study with bermudagrass strips found no significant effect on runoff at all. Those plots were short, and on 4 to 10% slopes, so they say little about redistribution across a long interval on Ethiopian slopes. They do mean that the infiltration below a hedge, on which both this mechanism and the Anno moisture interpretation rest, is something to measure rather than assume.

The same paper records a process that works in the opposite direction. Water leaving a hedge has dropped most of its load and has spare capacity to erode. On US cropland, channels below hedges kept eroding unless protected by backwater from the next hedge downslope, and the benching between hedges came partly from soil loss immediately below the upslope hedge. Modeling of the benched profile showed the slope just below each hedge steepening markedly. So the zone just below a hedge may be depleted by scour even while fines are being spread farther down the strip. Which effect dominates at Anno is an empirical question, and the transect would show it.

Competing explanations

Vetiver litter and roots add organic nitrogen directly, and the slightly higher C:N ratio in the vetiver soil hints at some high-carbon vetiver input, although both ratios need checking. Wedge sampling, feedback from larger crop residues, and differences in fertilizer history between the two areas could each contribute as well. On a farm that cultivates parallel to its hedges there is also tillage translocation: Meyer and colleagues found benching between hedges even where water erosion was minor, because tillage moves topsoil downslope and the hedge stops it. At Anno that would concentrate topsoil, and its nitrogen, above each hedge by a route that has nothing to do with runoff.

How to tell them apart

Explanation	Nitrogen along the transect	Texture and C:N
Sheet flow of fines	Elevated evenly across the strip below the hedge, no sharp gradient	Finer texture, higher clay, in the same zone
Deposition wedge	Peak some distance upslope of the next hedge, thinning toward it; the distance shortens as slope steepens	Coarser texture
Scour below the hedge	Depressed just below the hedge, recovering downslope	Coarser, depleted surface
Tillage translocation	Rising steadily toward the next hedge	Little texture sorting
Vetiver litter and roots	Peak on both sides of the hedge, decaying within the root spread	Higher C:N near the hedge
Fertilizer or management	Flat across the strip	No texture signal

Predicted signatures of six explanations for the Anno nitrogen difference. The wedge geometry follows the flume results in Meyer, Dabney and Kemper (2001).

The wedge row corrects an assumption we made earlier, and one that appeared in the Gibe Kabala note as well; that note has now been corrected. In the flume, deposition was not greatest at the hedge. It peaked just downstream of a hydraulic jump that formed where fast flow entered the ponded water, several meters upslope, and the deposit thinned toward the hedge. Nearly all sediment that reached the grass passed through it. The jump moved upslope as ponding deepened. On steep ground the ponded reach is short: the RUSLE guidance cited in the same paper gives no extra effective hedge width above 15% slope because backwater distances become minor. So on gentle slopes the wedge may be several meters long and peak well upslope of the hedge; on steep Ethiopian slopes it will be compressed close to the hedge. Transect sampling positions should be set by the local slope, not by a fixed distance.

Sediment collected just below a hedge after a major storm, analyzed for nitrogen and particle size, would show directly what is coming through. Because much of the fine material infiltrates rather than settles, such traps will understate what the strip retains, so they complement the soil transect rather than replace it.

8. A proposal: Anno as the mature end of a chronosequence

The Anno hedges are still in place, and they are now about thirty years old. That would make Anno the natural partner to Gibe Kabala: the same measurements on a two-year system and a thirty-year system, in

comparable country, would say more about how the vetiver effect develops over time than either site could alone. We would suggest the following, roughly in order of cost.

Site status: confirmed from space. Satellite imagery dated 14 January 2025 shows the Anno contour hedges intact. Neighboring smallholder farms also appear to carry vetiver hedges on the contour. January falls in the dry season, when living hedges are usually easy to pick out against harvested fields, but the species on the smallholder fields still needs confirming on the ground.

Date the spread to the neighbors. The smallholder hedges may be the most important thing at the site. If they appear in the image record after the farm's own planting and are closest to its boundary, that is spread by example, with no program behind it, over thirty years. A dated time series from the mid-1990s to 2025, using the Reading Vetiver from Space methods, would show when each hedge system first appears, how far adoption has spread from the farm, and whether any hedges were later abandoned. Short interviews with the farmers would then establish where the planting material and the idea came from.

Add the smallholder fields to the comparison. The neighbors give a third treatment that neither Anno nor Gibe Kabala has: smallholder hedges established without project support, of varying ages. Including some of them in the transect work would link the commercial result to smallholder conditions.

Ask the farm for its records. A commercial farm that has run vetiver for thirty years may hold what no research plot can: area protected, meters of hedge planted, establishment and maintenance cost, the cost of the terraces it replaced, and crop yields over time. Kumsa and Gobena (2009), the farm case study the paper cites, may be the place to start.

Run the Gibe Kabala transect protocol at Anno. Full inter-hedge transects, yield in bands, and soil at 0–20, 20–40 and 40–60 cm, using the same design proposed for Gibe Kabala so the two sites can be compared directly. Sampling should be dense enough near both hedges to catch the wedge peak and any scour zone, with positions set by the local slope. Particle size and C:N should be measured on every sample, since they are what separate the wedge, sheet-flow and litter explanations in section 7, and sediment should be sampled below hedges after a major storm. The depth sampling is the test of the subsurface phosphorus question. Several paired protected and unprotected areas across the farm would deal with the replication problem.

Repeat the pot trial with a sterilized split. This is the cheapest mechanism test we know of. Soil from each transect position is divided, half sterilized and half left live, and maize is grown in both. At harvest, root colonization is scored. If the advantage of vetiver soil shrinks when the soil is sterilized, part of it is biological; if maize in live vetiver soil is better colonized, the mycorrhizal mechanism has direct support. It needs a greenhouse and a microscope, not a field season, and it can be run on Gibe Kabala soils at the same time.

Build on existing links. The Anno paper came from Ambo University and Holeta Agricultural Research Center. Holeta sits within EIAR alongside Jimma and Wolkite, so a joint Anno and Gibe Kabala study would not need a new institutional arrangement. Alemu is best placed to make the approach to the farm and to Ambo.

9. Use in the policy case

For the ministry briefings, the two papers answer different objections.

Gibe Kabala answers the question of whether smallholders will take up the system and see results. Anno answers the question that usually follows: whether anyone has kept it going once the project left. Here there was no project. A commercial investor tried terraces, found them expensive and fragile, chose vetiver, and, on the evidence of the paper and of imagery dated 14 January 2025, has kept it for thirty years. That is the procurement argument in miniature, and it comes from the private sector rather than from advocates.

The neighboring smallholder hedges may add a second argument. If ground checks confirm that they are vetiver and that they followed the farm's example, Anno is also a case of farmer-to-farmer diffusion from a commercial demonstration, sustained over decades without extension support. That is worth presenting carefully, as a finding still to be confirmed, but it goes directly to the question ministries ask about any technology: whether people will adopt it when nobody is paying them to.

There is also a direct precedent for the institutional step. Meyer, Dabney and Kemper (2001) describe how the USDA response to vetiver advocacy went from a 1989 workshop, through flume, plot and field trials, to interim practice standards in state NRCS offices, eligibility for federal cost-sharing, and recognition of vegetative barriers as one of the conservation buffer types in the national CORE4 program. The research was designed from the outset to end in a standard an action agency could apply. That is the sequence we are urging on Ethiopia, and it has been done before in a country with a far larger conservation bureaucracy.

We would recommend citing Anno for self-adoption, persistence and the direction of the soil changes, and being conservative with its numbers. The soil differences are real but come from a single paired comparison, and the carbon benchmark in section 3 should be presented as a benchmark, not as a sequestration rate. If the farm's own cost and yield records can be obtained, they would be worth more in a ministry meeting than the soil data.

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