VETIVER – THE PLANT

Vetiver, formerly known as (*Vetiveria zizanioides L. Nash*), now reclassified as (*Chrysopogon zizanioides L. Roberty*), is a fast growing perennial plant with an extensive, dense and deep root system and strong stems, resulting in a versatile non-invasive plant now widely used to address a myriad of environmental and engineering soil and water related problems.

It thrives in the tropics and subtropics, extending up to the border of the temperate zone

Vetiver is the most researched non-agricultural and non-industrial plant ever reported in the literature.

Vetiver Characteristics – Shoots

STRONG, STIFF & THICK SHOOTS

- **Perennial tufted grass**
- **Create dense hedges when planted close together**
- **Dissipate wind and water energy**
- **Slow down water flow**
- **Withstand high velocity flows of 5m/sec**
- **Control and spreads water run off**
- **Trap sediments**
- **Increases water infiltration and retention**
- **Recharge groundwater**
- **Flower but does not produce seeds, which means it is sterile**

  = NO WEED POTENTIAL = NON-INVASIVE
- **Can grow up to 3 metres tall**

Vetiver Characteristics - Stems

Erect stems up to 3m tall

Forming a thick hedge

Even at this young age the stem is strong enough to trap large size gravel

Strong flash flood flattened the native grass but not Vetiver on this waterway

Vetiver Characteristics - Roots

STRONG, DENSE, DEEP & PENTRATING ROOTS

- **Tensile strength 1/6th of mild steel = 75Mpa**
- **Improve soil sheer strength by 45%**
- **Grow vertically, reaching depths of 5+ meters**
- **Interlocking and dense root matrix create vast, dense and strong underground "walls", reinforcing soil conditions**
- **Uptake nutrients and moisture from deeper soil depths = drought resistant**
- **Can develop new roots from nodes when buried**
- **Increases soil microbial activity, breaking down and absorbing and tolerating heavy metal toxicities, herbicides, pesticides and excess nutrients – allowing for rehabilitation and revegetation of soil**
- **Remediate contaminated wastewater**
- **Fine root structure – does not interfere with the integrity of infrastructure**

Vetiver Characteristics - Roots

Longitudinal section of hedge

Vetiver Characteristics - Resilience

- **Thrives in a variety of soils: sandy, saline, water logged, highly contaminated, extreme acidic and alkaline (pH 3.3 – 12.5)**
- **Withstands prolonged periods of flooding and drought**
- **Crown adjusts itself to ensure it will not be buried alive**
- **Survives ground surface temperatures of -15°C and air temperatures of 55°C**
- **Disease and pest resistant**
- **Crown grows below the surface, to protect itself from fire, grazing and trampling**

A 30 year old quarry waste dump

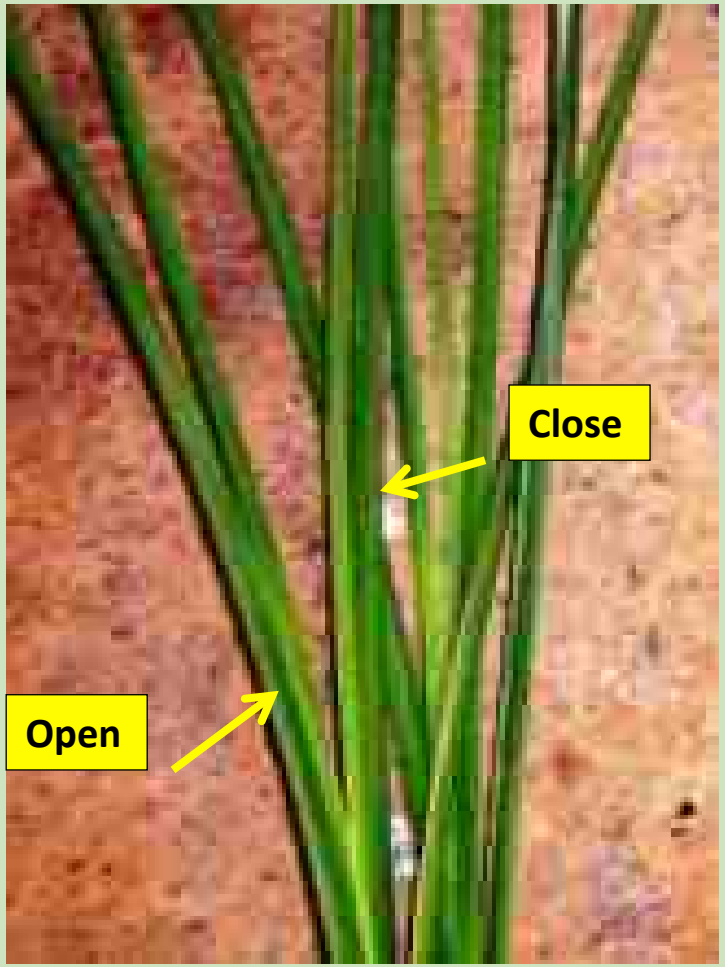
Thirteen months after planting

Established on semi-arid tropical road batter and acting as nurse crop for volunteer plants

Some Unique Attributes of Vetiver Grass

Vetiver Shoots

Vetiver has an unusual leaf and shoot architecture. Unlike most of other grasses, Vetiver has a V shaped leaf with a prominent mid rib, which can control the opening or closing of the leaf blades. Under moist or wet conditions, the leaves open up, resulting in higher transpiration rate. But under dry conditions, the leaves close up resulting in lower transpiration rate to conserve moisture



Close Half open Full open

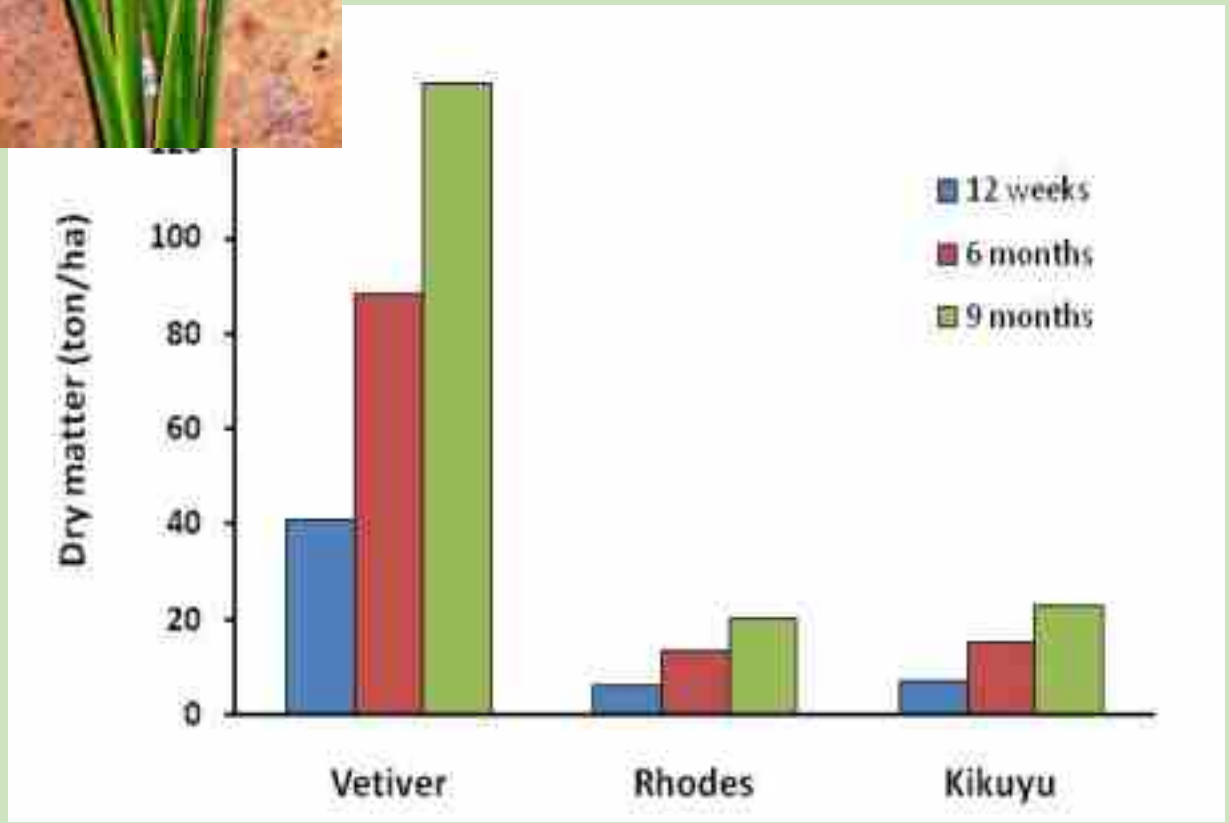
V shape leaves with a prominent mid rib which can open or close leaf blade

Vetiver Shoots

Vetiver is a C4 plant exhibiting superior growth characteristics. The stiff and erect shoots form a dense funnel shape canopy with leaf angles varying between 45° - 135°, not flat or horizontal like broadleaf plants or most grasses. This shoot architecture has several important implications: the longer sunlight interception of individual leaves as the sun moves from east to west, sunlight interception from both sides of the individual leaf, exposing most of the leaves simultaneously to sunlight, with minimal shading of leaves within the canopy as most other plants. Consequently, larger leaf surfaces of Vetiver are exposed to sunlight over a longer time for photosynthesis, leading to better growth as compared to other plant species.

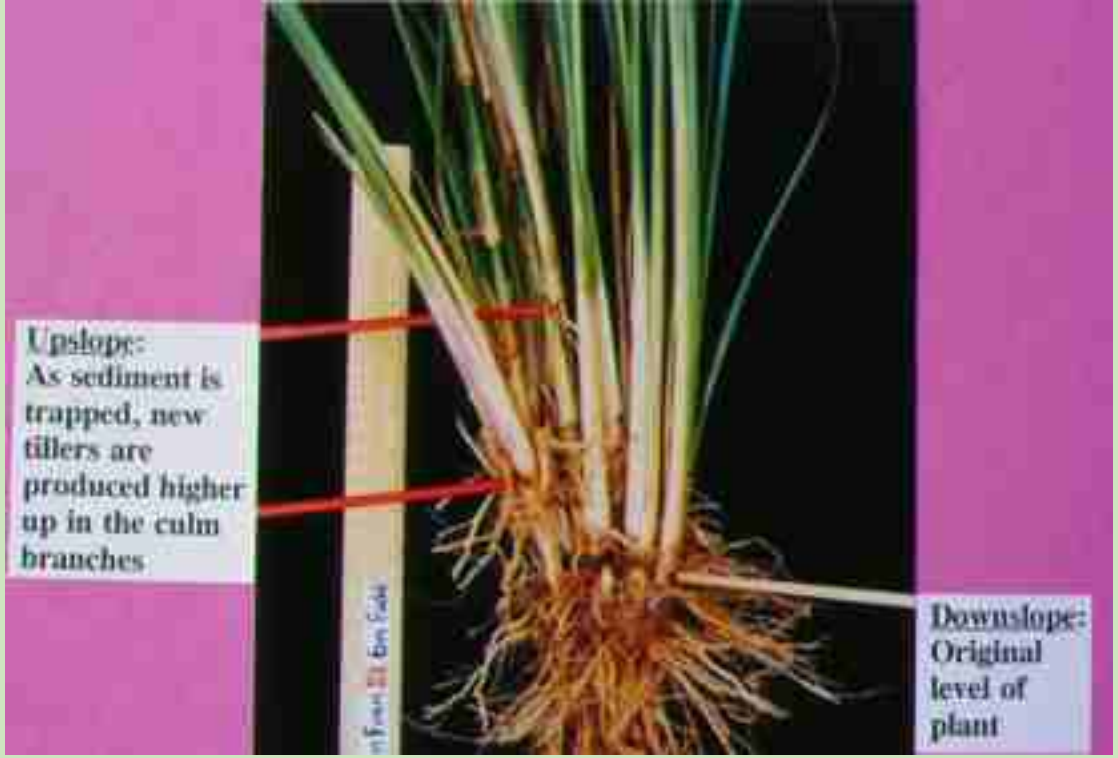
Vetiver Growth and Biomass

As a result of the unique photosynthetic ability mentioned above, Vetiver can under good management produce massive biomass, 100t/ha under field conditions and 130t/ha under experimental conditions.



Potential dry matter yield of three grasses over time

This image shows the uniqueness of vetiver's propagation ability. When soil builds up behind a vetiver grass plant new roots grow from nodes on the culm. Thus vetiver can never be "drowned" in soil or mud. This characteristic accounts for the plants ability to create terraces on the up slope behind the vetiver hedgerow.



This classic photo from Malaysia (rainfall 2,500 mm) shows the cross section of a two year old vetiver hedgerow on a 5% slope.
The original head line was planted along the line of the white stake. The original topsoil layer is the dark band. 30 cm of soil has built up behind the hedge to create a terrace, the hedge has grown with the terrace.

Vigorous growth and massive biomass under favorable conditions

Ten year old vetiver clump and regrowth after rain

Vetiver Grows Under Extremely Adverse Conditions

Arid tropical savannah

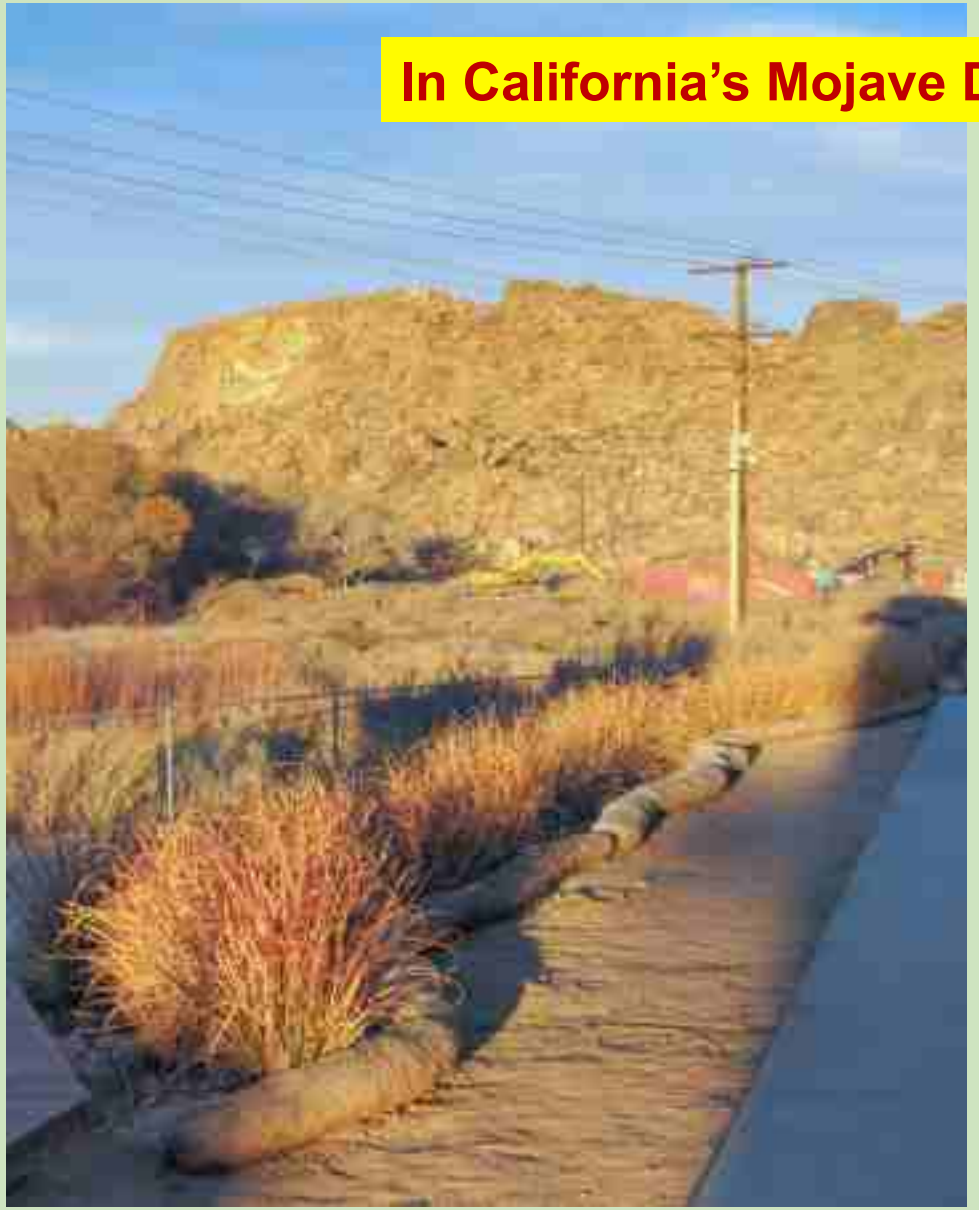
On beach sands

In water

On heavy black cotton soil

Vetiver Grows Under Extremely Cold Conditions

Vetiver was covered by 35cm of snow for 4 days and fully recovered in spring in Jordan



In California's Mojave Desert

Vetiver grass can survive temperatures as low as minus -12ºC (10ºF) if daytime temperatures rise well above freezing and the ground is not frozen.

Summer heat is often at 43+ºC (110+ºF) or higher

Vetiver Is Fire Proof

Soil is a very good insulator, as Vetiver buds are underground, they are not affected by fire






Regrowth after severe wild fire – hedgerows maintain their effectiveness below ground during recovery.

Vetiver Grows Under Extremely Acidic Conditions

Vetiver thrives at soil pH=3.8 and Aluminium Saturation Percentage (ASP) of 68% and 87% under field conditions

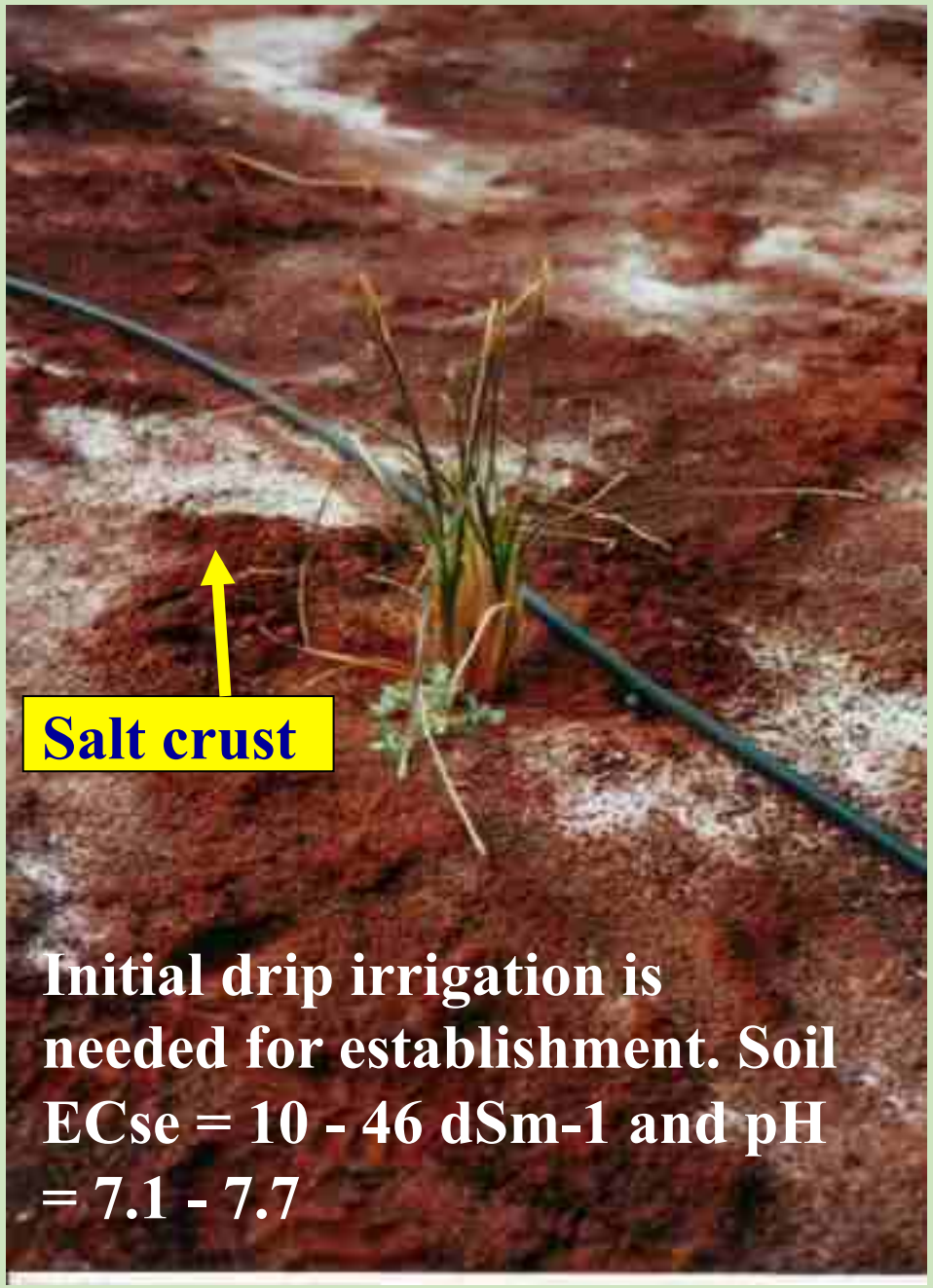
Highly erodible acid sulfate soil (pH 3.0) in coastal Australia

One year after planting on acid sulfate soil (pH 3.0) in coastal Australia

Vetiver is Highly Tolerant to Saline Conditions

Vetiver can survive at soil salinity level of Ecse = 47.5 dSm^{-1} under dryland salinity conditions

Vetiver growing between mangrove seedlings in brackish water



Highly saline Gribble Creek flat in Kalgoorlie, Western Australia

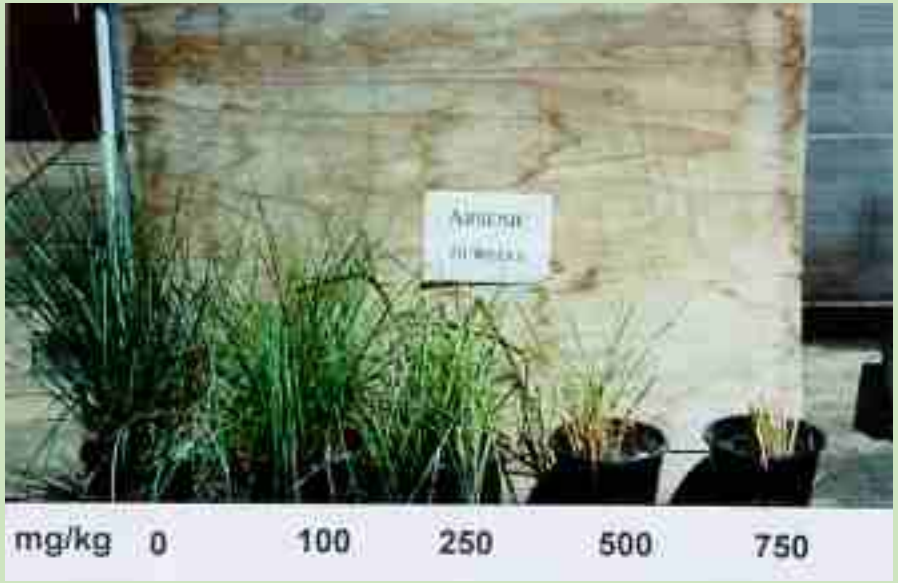
Vetiver still thrived 4 weeks after planting

Vetiver Is Highly Tolerant To Heavy Metals Pollution

Toxic threshold for Mn: 578mg/kg

Toxic threshold for Zn750mg/kg

Toxic threshold for Pb: > 1 000mg/kg



Toxic threshold for As: up to 250mg/kg

Vetiver Longevity

This Vetiver row planted in 1912 on a coastal path in Vanuatu, a South Pacific Island, to control coastal erosion, it has survived about 100 years (Don Miller, New Zealand).

Its longevity and persistence can be attested by the fact that it is often used as a survey marker to delineate farm boundary in India and the Philippines

The young plants grow up into a thick and continuous hedge. This hedge in Zambia was planted on a research station (1200 mm rainfall) in 1926. In 1986 it was still there.