VETIVER SYSTEM FOR INDUSTRIAL WASTEWATER TREATMENT AND DISPOSAL AT GELITA APA, QUEENSLAND, AUSTRALIA

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Introduction

GELITA
ASIA PACIFIC AFRICA

- The GELITA factory extracts gelatine from cattle hide using chemical processes involving strong acids, lime and hydroxides.

- This factory situated on a property of 170 hectares, at Beaudesert in Queensland, Australia, generates approximately 1.3 ML a day of wastewater

- The effluent from the processing plant is highly saline (average 6 dS/m), alkaline and high in N (300 mg/L) and low in P (2 mg/L).

- The effluent is disposed off by irrigating over 121 hectares of Kikuyu and Rhodes grasses pasture.

Constraints

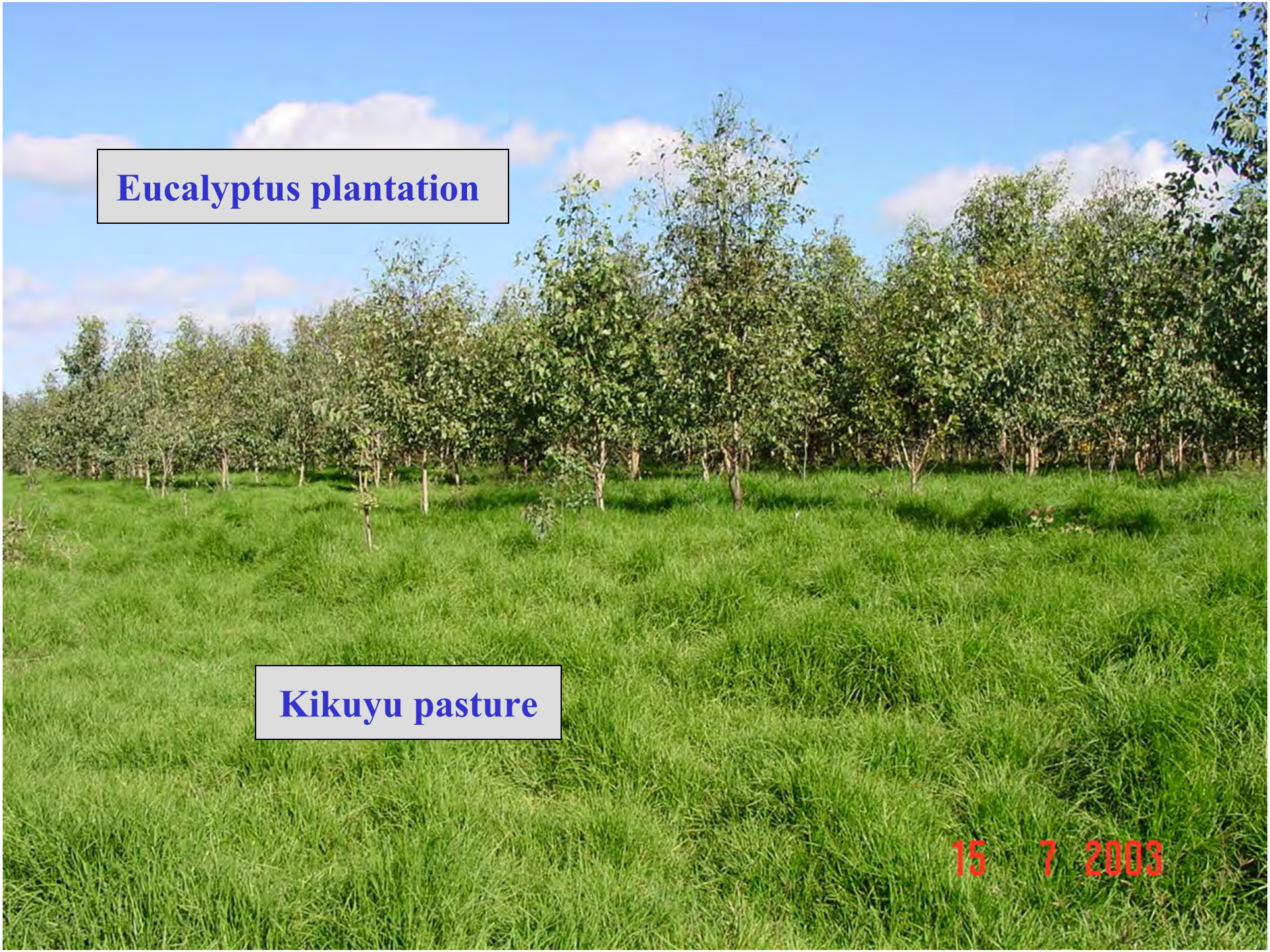
The Queensland government has applied strict regulations regarding the disposal of this wastewater. In order to meet these regulatory requirements and to fulfil expectations of the Ecologically Sustainable Development, GELITA has undertaken a comprehensive research program to develop optimal disposal methodologies.

Due to extreme climatic variations over the seven years of operation the planting of pasture and annual crops has not provided a viable operational methodology.

A typical effluent storage pond at GELITA, Beaudesert

Rhodes grass pasture at GELITA

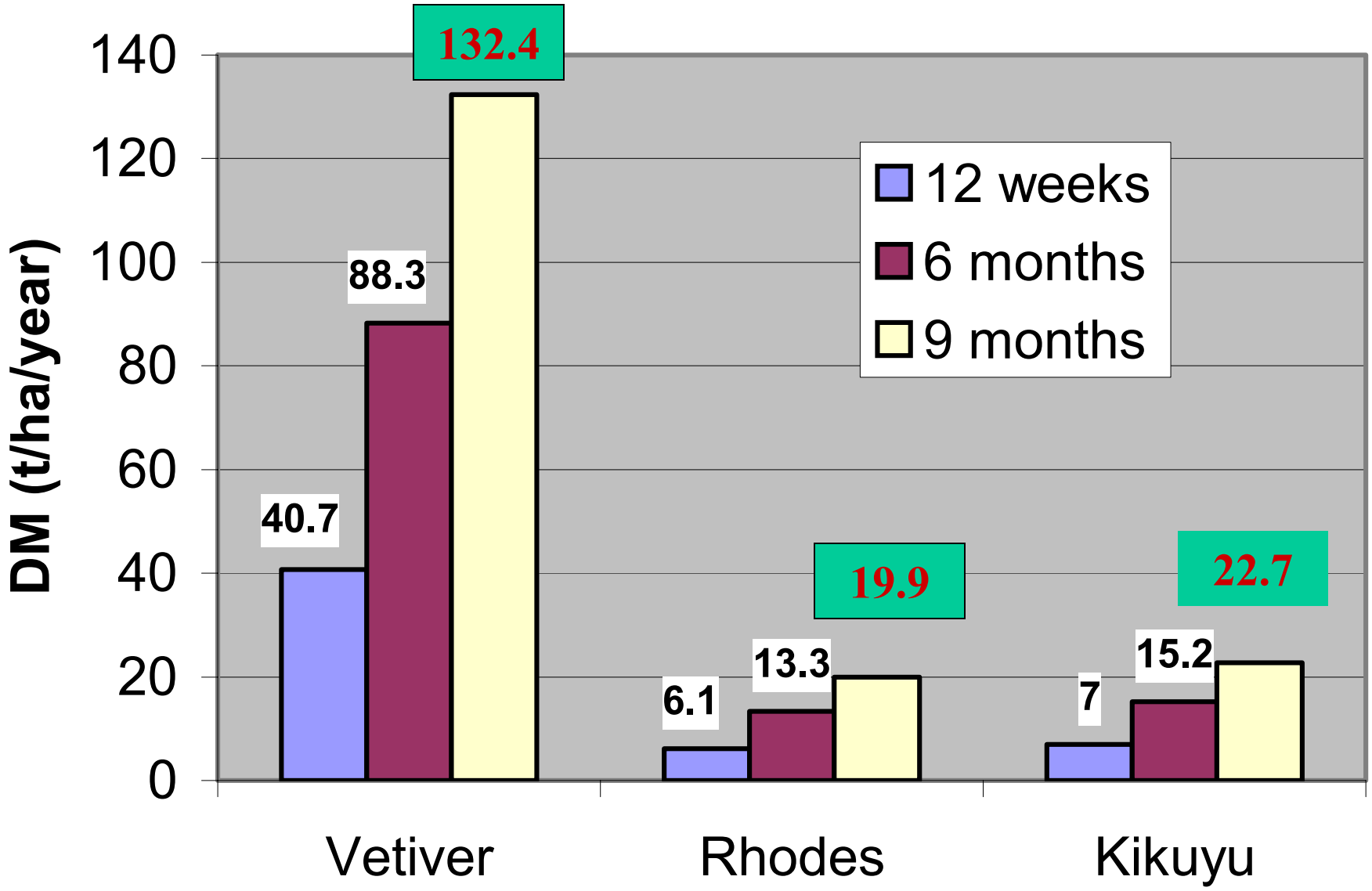
Kikuyu grass pasture


Eucalyptus plantation
Kikuyu pasture
15 7 2003

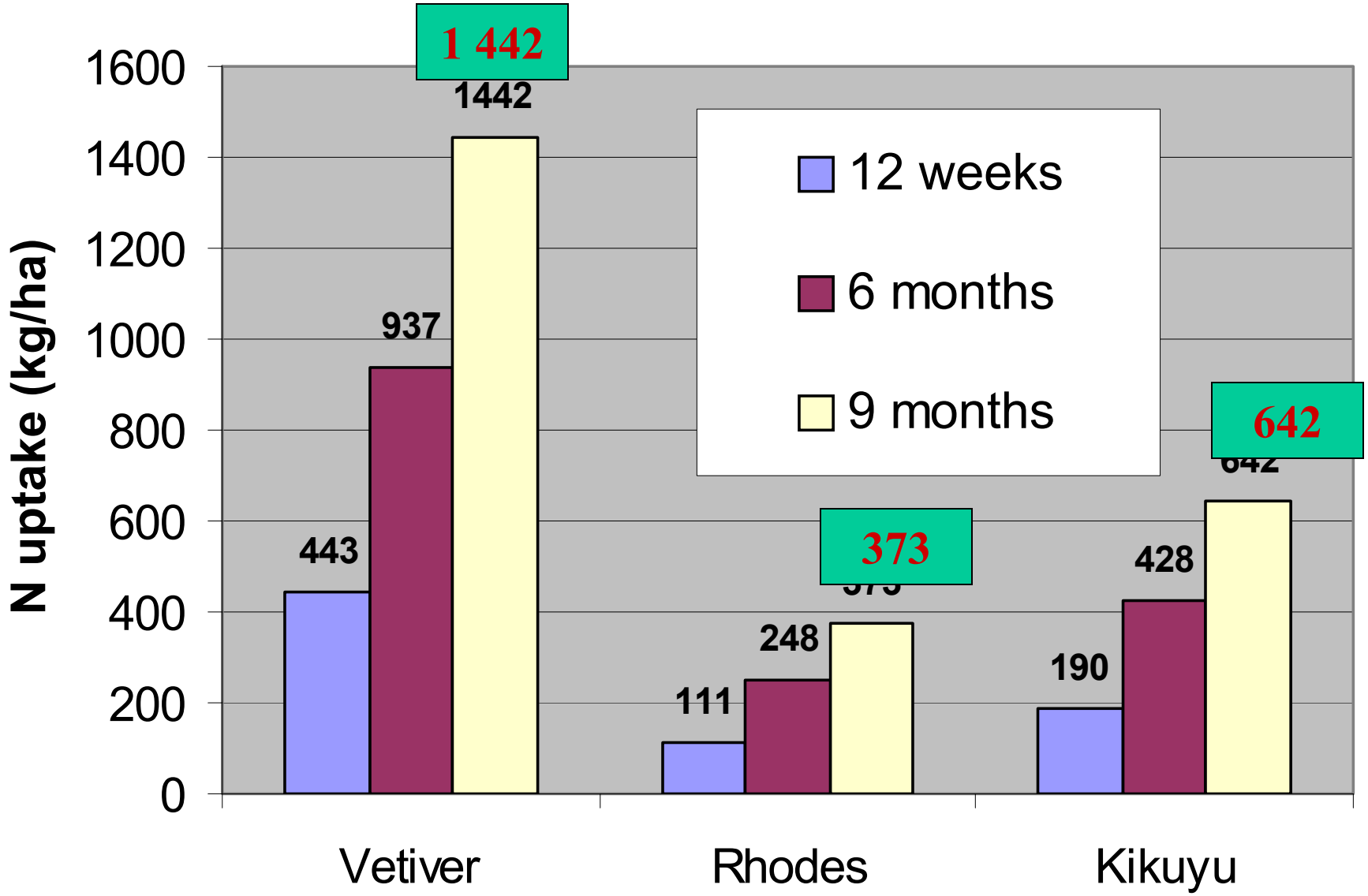
Vetiver pasture six months after planting

Growth after 12 months

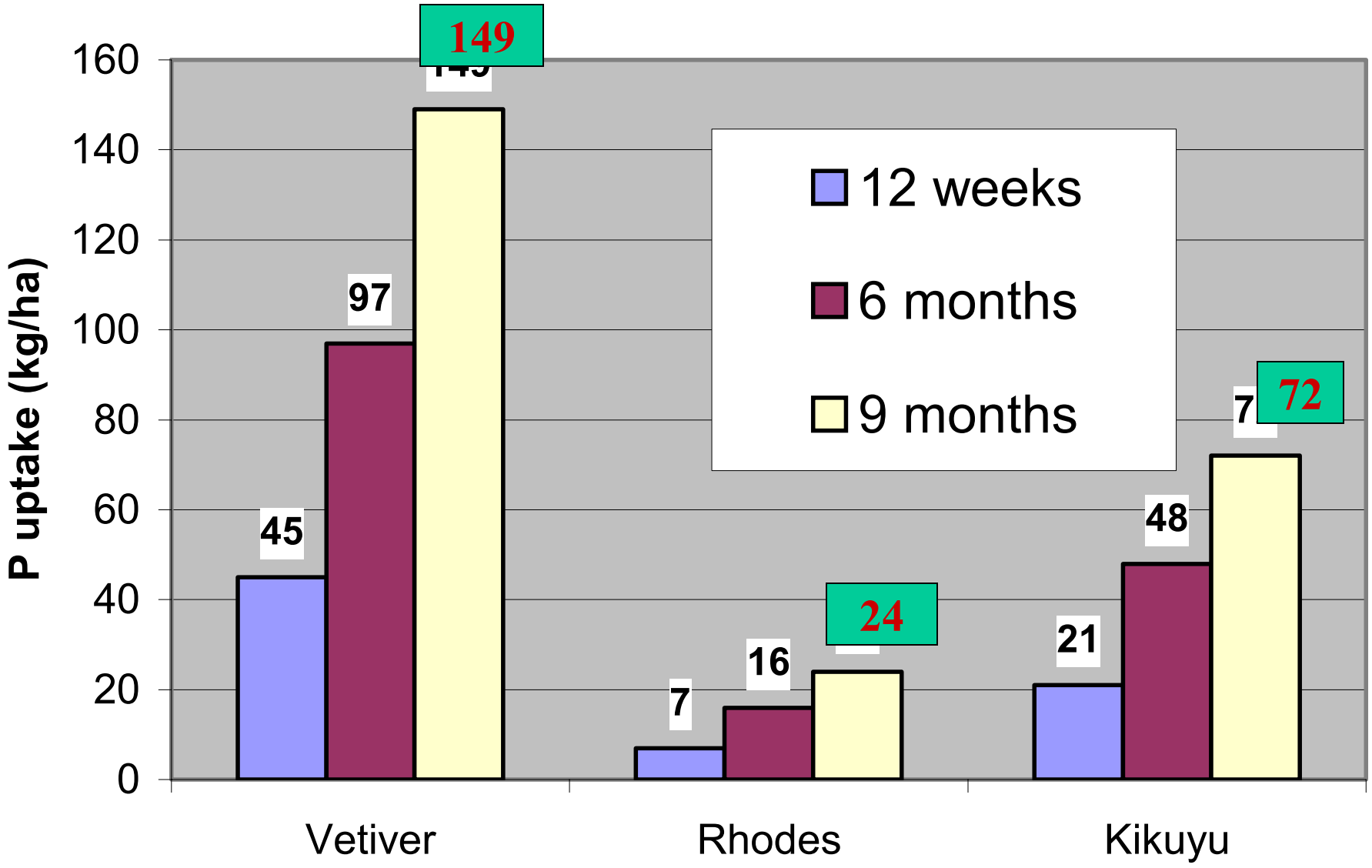
Comparative yield between vetiver, Rhodes grass and Kikuyu grass



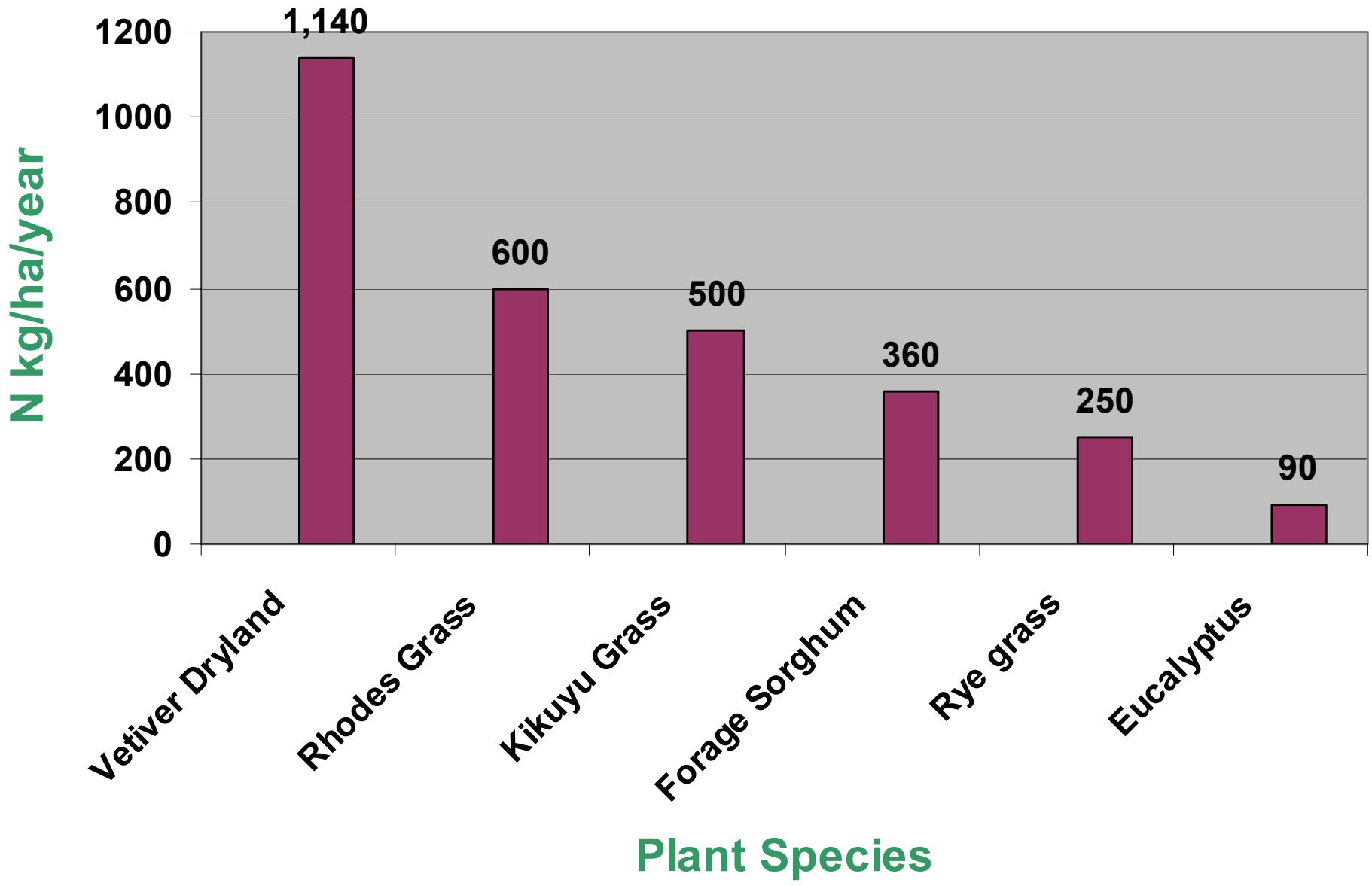
Comparative N uptake between vetiver, Rhodes grass and Kikuyu grass



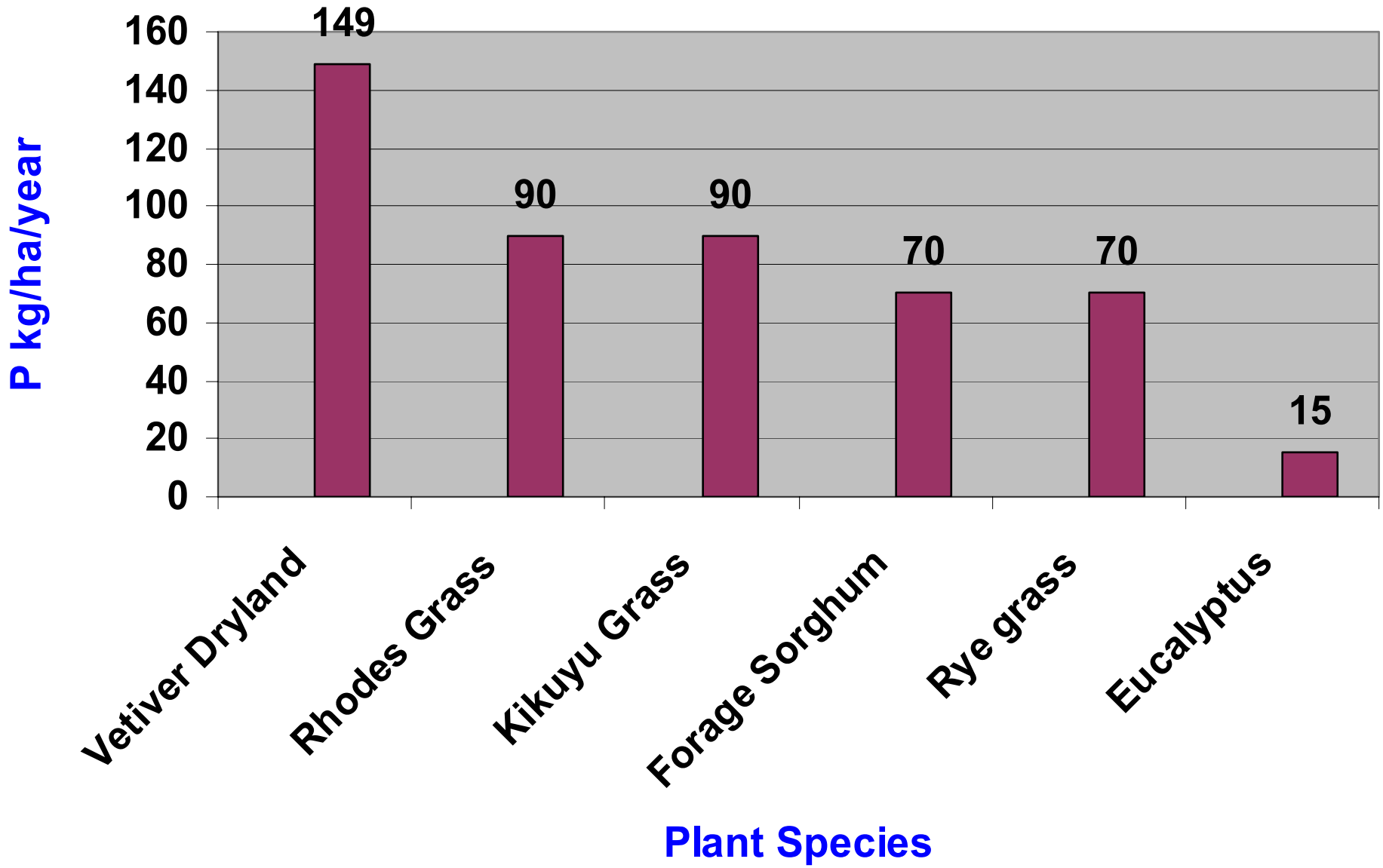
Comparative P uptake between vetiver, Rhodes grass and Kikuyu grass



NITROGEN UPTAKE



PHOSPHORUS UPTAKE



Options and Solutions

- Alternative solutions such as chemical treatment plant and transportation to sewage treatment plant were considered but both of which are impractical and most importantly very costly to build and to operate.
- Tree planting was one of the earlier options considered, it has been trialed for several years but has not provided an effective solution to the problems faced by the company.
- Application of the Vetiver System for wastewater treatment is a new and innovative phytoremedial technology and VS was identified as having the potential to meet all the criteria.
- The vetiver option using MEDLI as a model offers a practicable and cost effective solution.

The MEDLI Computer model

MEDLI is a Windows based computer model for designing and analysing effluent disposal systems, which use land irrigation, for a wide range of industries such as piggeries, feedlots, abattoirs, sewage treatment plants, and food processing factories.

Land area required for irrigation and N disposal

Plants	Land needed for irrigation (ha)	Land needed for N disposal (ha)
Vetiver	80	70
Kikuyu	114	83
Rhodes	130	130

CURRENT VETIVER SYSTEM RESEARCH, DEVELOPMENT AND APPLICATIONS

- Soil Based Reed Beds
- Agrochemical Retention and Disposal
- Evapo-transpiration of Vetiver Grass
- Vetiver Essential Oil For Pest Control and Pharmaceutical Uses
- Effects of Vetiver Grass on Some Soil Physical Properties

SOIL BASED REED BEDS RESEARCH OBJECTIVES

SHORT TERM

- **Although MEDLI has reduced the planting area from 130ha to 70ha, this model is designed as an effluent disposal method.**
- **GELITA is interested in more advanced applications of VS in effluent treatment and the Company is interested in conducting research in the Soil Based Reed Beds system with the aims of reducing this planting area further and recycling of the wastewater**

SOIL BASED REED BEDS RESEARCH OBJECTIVES

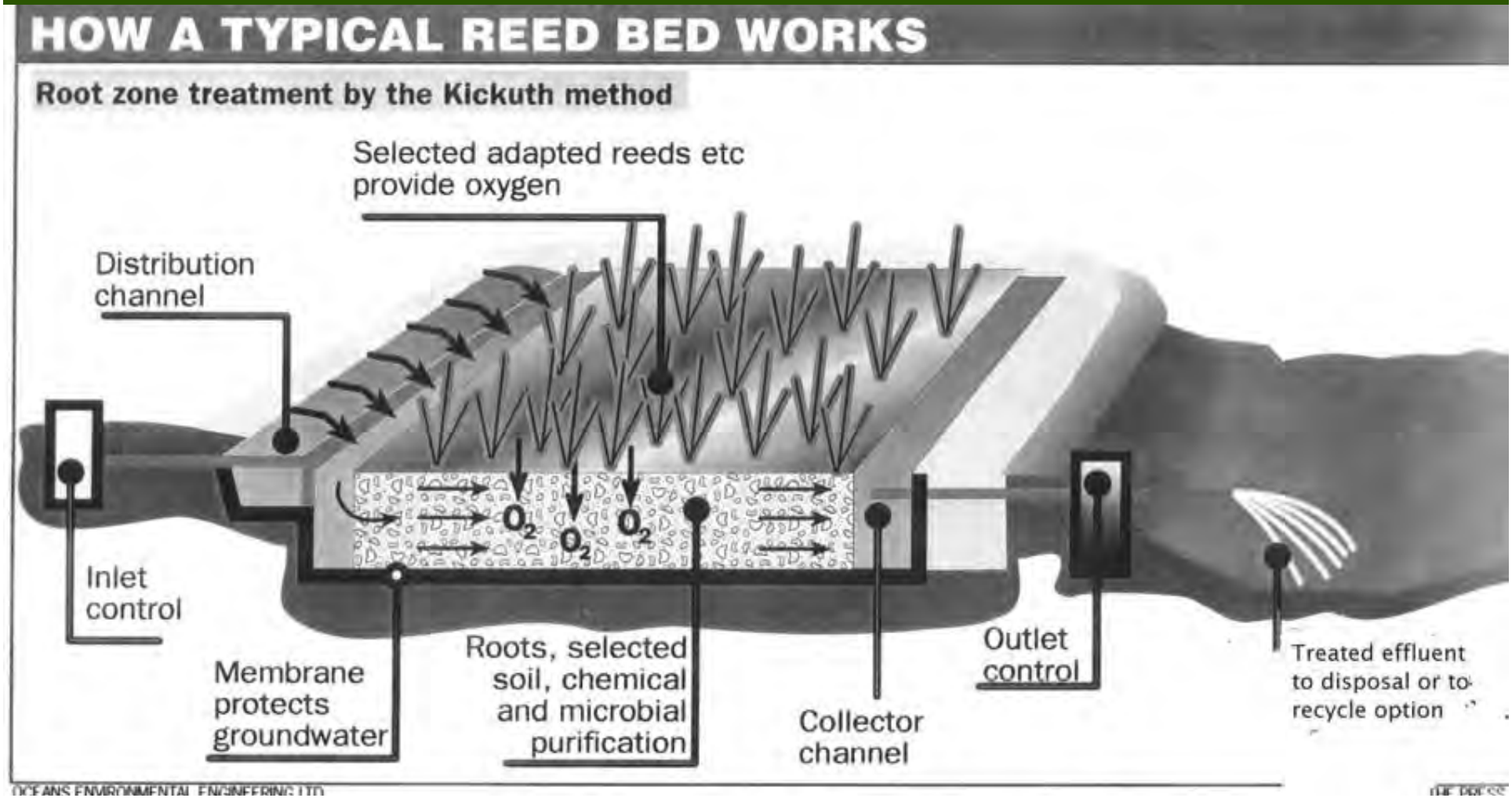
LONG TERM

- **Demonstrate the suitability of vetiver grass for use in the SBRB system to treat nitrogen rich industrial effluent**
- **Use the research findings in order to develop and establish a SBRB system that is capable of purifying GELITA's wastewater to a satisfactory level and**
- **Develop a SBRB system using vetiver grass suitable for Australia and world wide**

Soil Based Reed Beds (SBRB)

The SBRB system has three simple components:

- **A shallow bed of soil**
- **A suitable plant**
- **Micro-organisms (fungi and bacteria)**



WHY VETIVER GRASS INSTEAD OF PHRAGMITES

Traditionally *Phragmites australis* is the preferred species in reed bed planting.

However Phragmites has:

- **a relatively shallow root system, typical feature of wetland plants**
- **a slow recovery growth after harvesting as it relies on the growth of new shoots from rhizomes and seeds instead of the old shoots.**
- **a major weedy pest in all wetlands and waterways due to its prolific seeding habit**

WHY VETIVER GRASS INSTEAD OF PHRAGMITES

Whereas Vetiver:

- Has a prolific and deep root system
- Tolerant to high level of pollutants, including heavy metals and nutrients particularly N and P
- Has high capacity of absorbing these pollutants
- Grows well under extremely adverse conditions such high salinity, high acidity and alkalinity and sodicity
- Is sterile and producing no seeds therefore no weed potential

Soil Based Reed Beds with clay, sand and gravel beds at GELITA

VETIVER GRASS IN REED BEDS

Summerfelt *et al* (1999) used vetiver grass in a study for the removal and stabilization of aquaculture sludge, has found that Vetiver removed:

- **Total Suspended Solid 96- 98 %**
- **Total COD 72- 91 %,**
- **Dissolved COD 30-81%**
- **Dissolved phosphate, total Kjeldahl nitrogen, and total phosphorus 82−93%**

AGROCHEMICAL RETENTION AND DISPOSAL

OBJECTIVES

- **To demonstrate the benefits of vetiver grass filter strips on farms in reducing herbicide movement into the aquatic environment**

- **To develop a simple system suitable for easy adoption by the farming community to improve water quality**

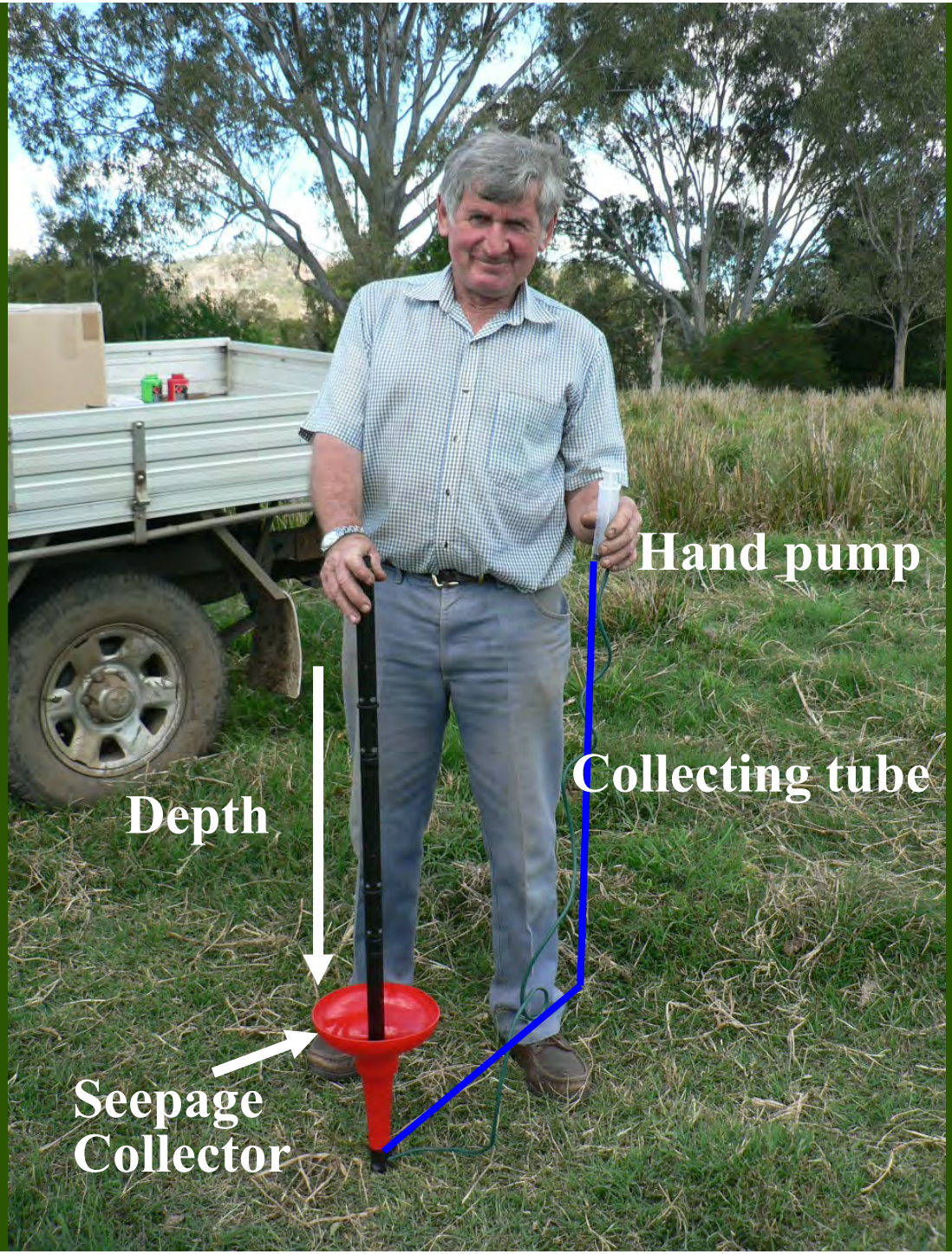
- **To promote the adoption of the Vegetative Buffer Strip for Soil Erosion & Deposition model developed by Griffith University, Brisbane, Australia**

Atrazine Capture and Retention Project

18 month old vetiver ready for treatment

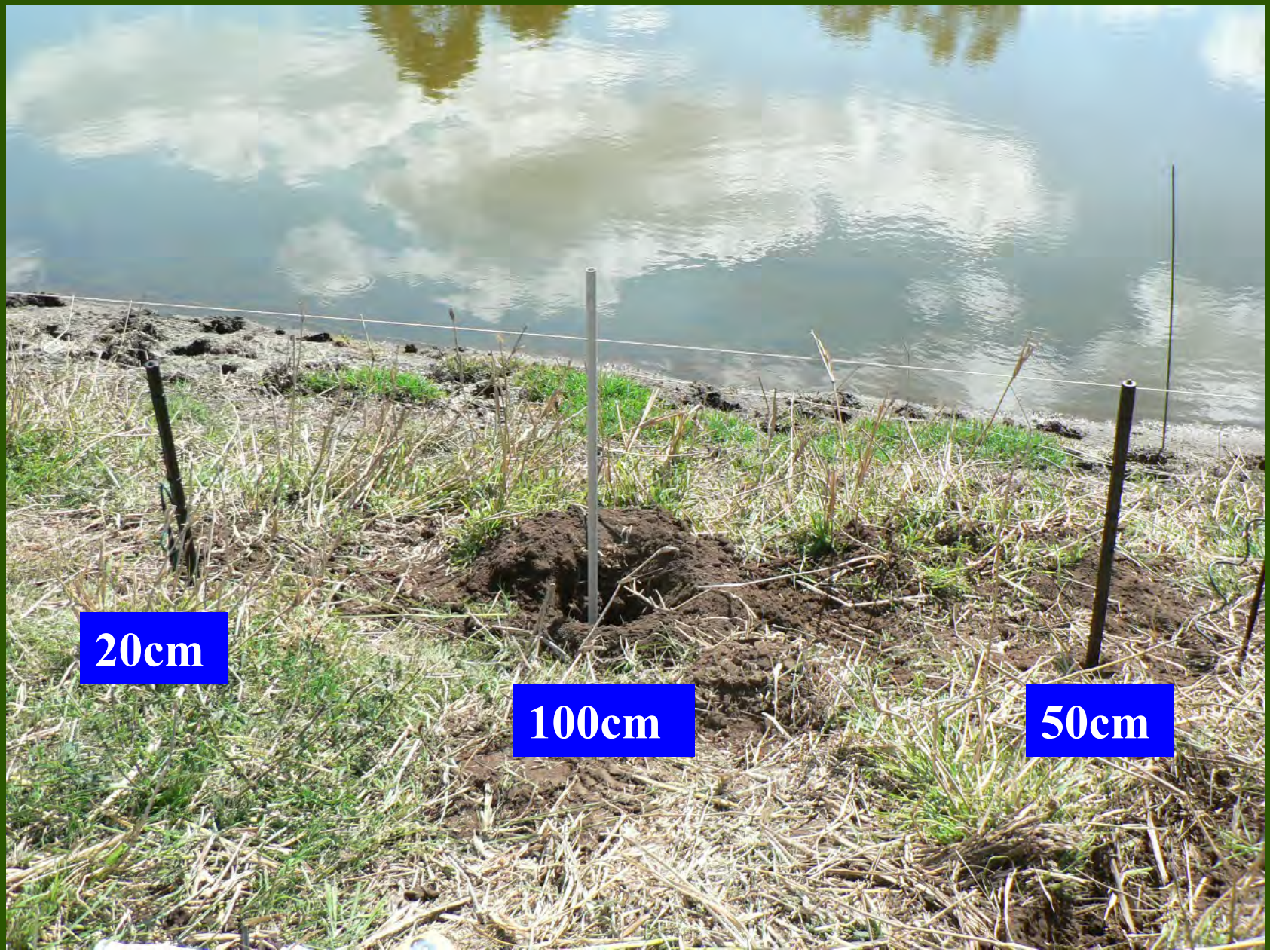
Nine sets of sampling points, each at 3 depths: 20cm, 50cm and 100cm

Boring for installation of monitors



FullStop subsoil seepage monitor

A set of sampling point with 3 collectors at 20cm, 50cm and 100cm depth



EVAPO-TRANSPIRATION OF VETIVER GRASS

OBJECTIVES

The principal objective is to determine accurately the transpiration rates

The evapo-transpiration rate of vetiver reported in the literature varied from 3.8 mm/day in summer and 1.9 mm/day in winter under field conditions to 43 mm/day under effluent treatment conditions. These are up to 4-10 times greater than normal rates.

If such extreme claims are incorrect, environmental damage could result from undersized effluent irrigation schemes.

Twelve bays all set ready for planting


Sampling outlet
Inlet
19 7 2006

VETIVER ESSENTIAL OIL FOR PEST CONTROL AND PHARMACEUTICAL USES

OBJECTIVES

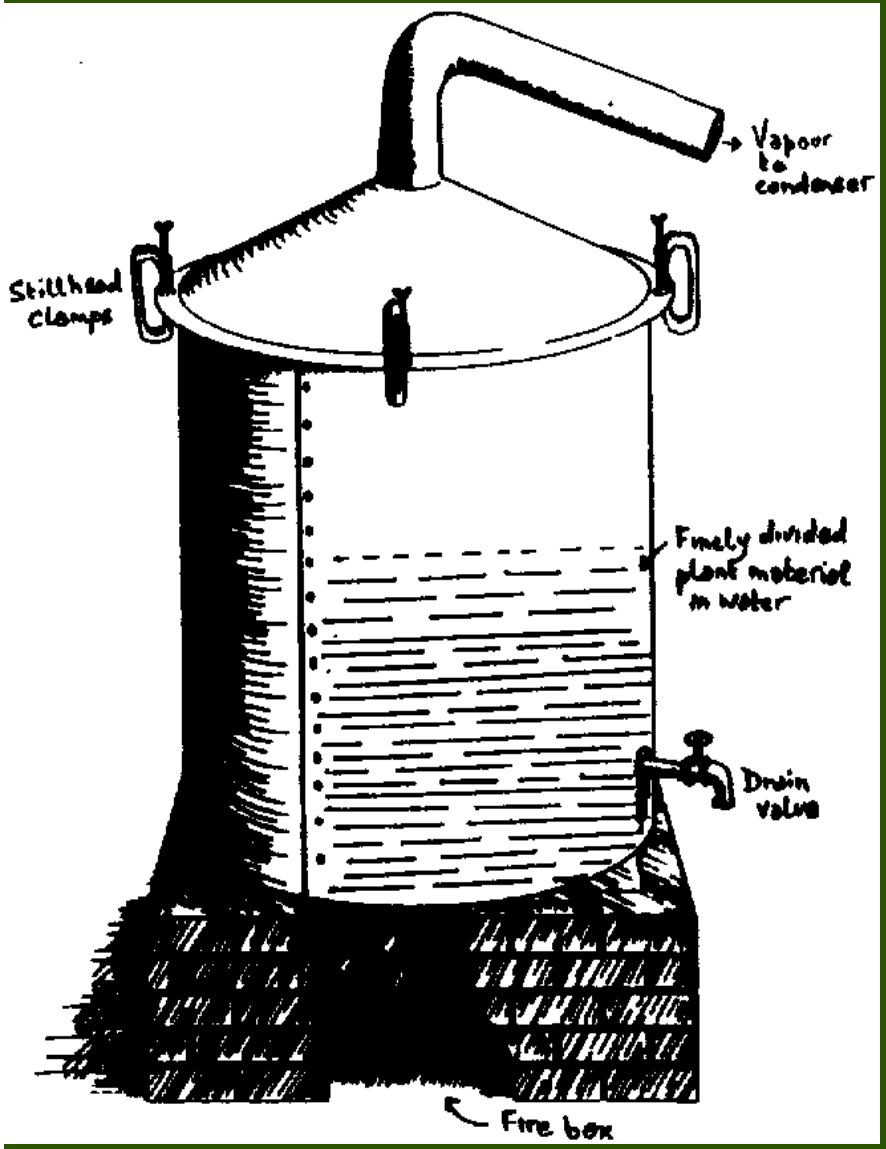
Literature search has indicated that vetiver essential oils (VO) for has Antibacterial, Antifungal, Antioxidant and Anti-inflammatory attributes.

The aims of this project are to:

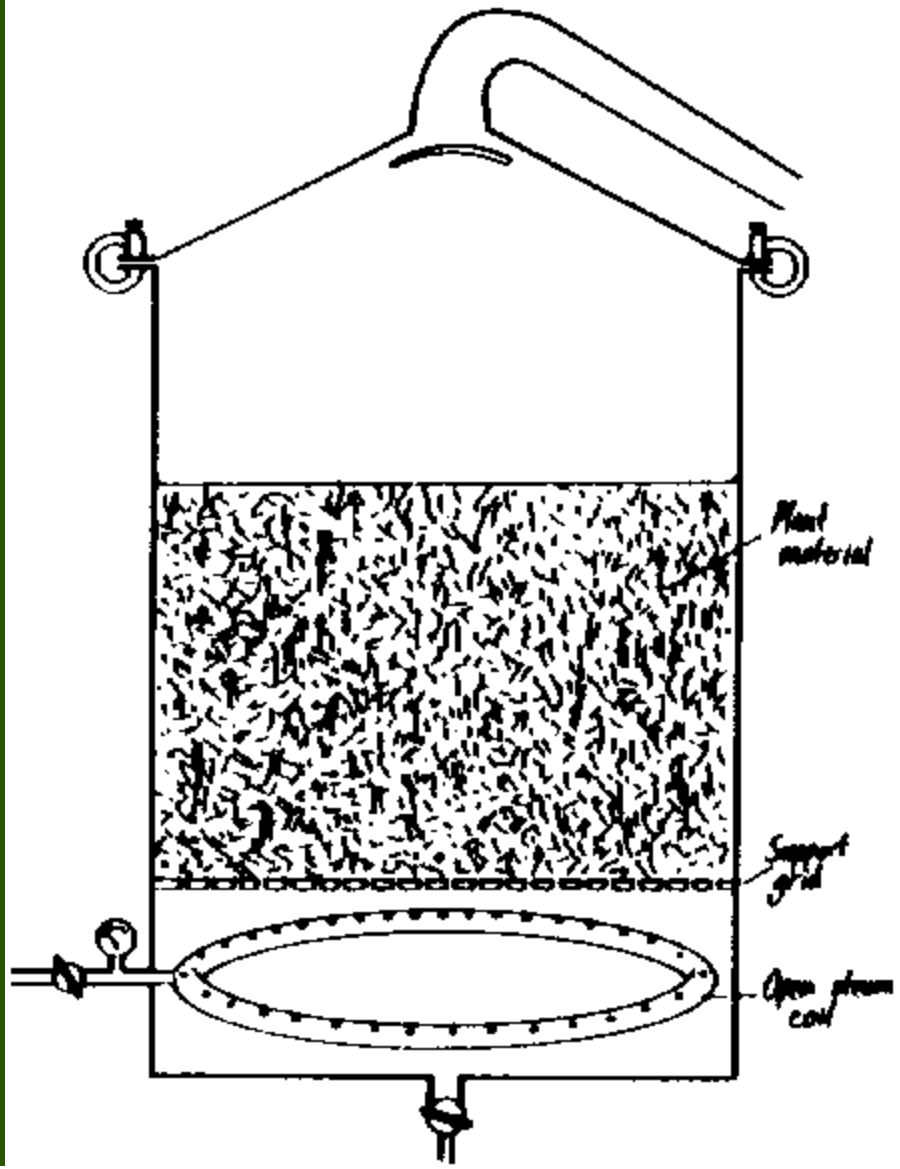
- **Determine the best extraction methods for α-vetivone and β-vetivone and may be of other components as well.**
- **Determine Vetiver species has high content of α-vetivone and β-vetivone at which stage of growth.**
- **Determine whether VO can be extracted from leaves**
- **Whether heavy metals and other chemicals will affect the quality and quantity of VO**
- **Whether VO contains heavy metals and other chemicals when used for phytoremediation**

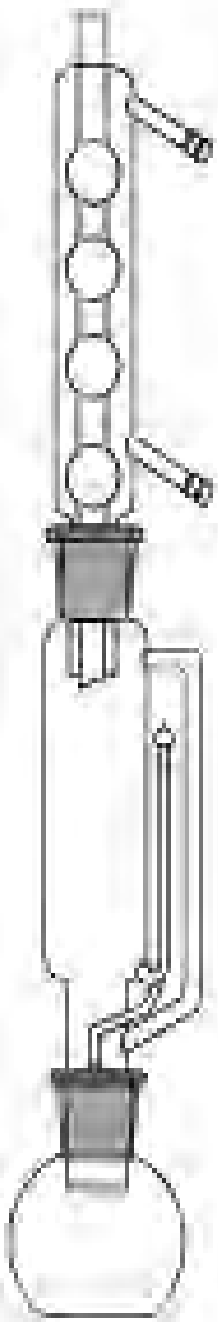
Extraction Methods

Hydro distillation



Steam distillation





Solvent extraction

EFFECTS OF VETIVER GRASS ON SOME SOIL PHYSICAL PROPERTIES

OBJECTIVES

Due to its extensive, deep and penetrating root system, it is expected that some soil physical and chemical parameters would be improved under vetiver cultivation

The aims of this project are to:

- **Monitor the changes in hydraulic conductivity and soil bulk density**
- **Monitor the changes in salinity and soil chemistry on various soils within the GELITA property**
- **Provide soil-water parameters, which will determine appropriate irrigation management and monitoring programs**

Determining saturated hydraulic conductivity

Testing Guelph Permeameter

Guelph Permeameter in the field

Producing fodder for livestock from effluent
Grazed readily by cattle