VETIVER SYSTEM FOR STRIP CROPPING ON THE FLOODPLAINS IN QUEENSLAND, AUSTRALIA

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Special Morphological Features

- **Erect and stiff stems**
- **Extensive, deep and penetrating root system**
- **Forming thick hedges**

STIFF AND ERECT STEM

Up to 2m tall in one year

Forming a thick hedge when planted close together

Strong current flattened the native grass but not vetiver on this waterway

Thick growth forming a very effective filter, trapping sediment

DEEP, EXTENSIVE AND PENETRATING ROOT SYSTEM

One year old: 3.3m deep

Special Physiological *Features*

Tolerant to:

- **Extreme weather (-14ºC to 55ºC)**
- **Drought and water logging**
- **Fire**
- **Adverse soil conditions: salinity, acidity, alkalinity and sodicity**
- **High agrochemical and nutrient levels**
- **Heavy metals: Al, As, Cd, Cu, Cr, Hg, Ni, Pb, Se and Zn.**

Extremely drought tolerant as compared with native grasses under semi arid climate in Queensland, Australia

Growing vigorously in water in flooded dam

Salt tolerance level of Vetiver grass as compared with some crop and pasture species grown in Australia.

Species	Soil EC_{se} (dSm^{-1})	
	Saline Threshold	50% Yield Reduction
Bermuda Grass *(Cynodon dactylon)*	**6.9**	**14.7**
Rhodes Grass (C.V. Pioneer) *(Chloris guyana)*	**7.0**	**22.5**
Tall Wheat Grass *(Thynopyron elongatum)*	**7.5**	**19.4**
Cotton *(Gossypium hirsutum)*	**7.7**	**17.3**
Barley *(Hordeum vulgare)*	**8.0**	**18.0**
Vetiver *(Vetiveria zizanioides)*	**8.0**	**20.0**

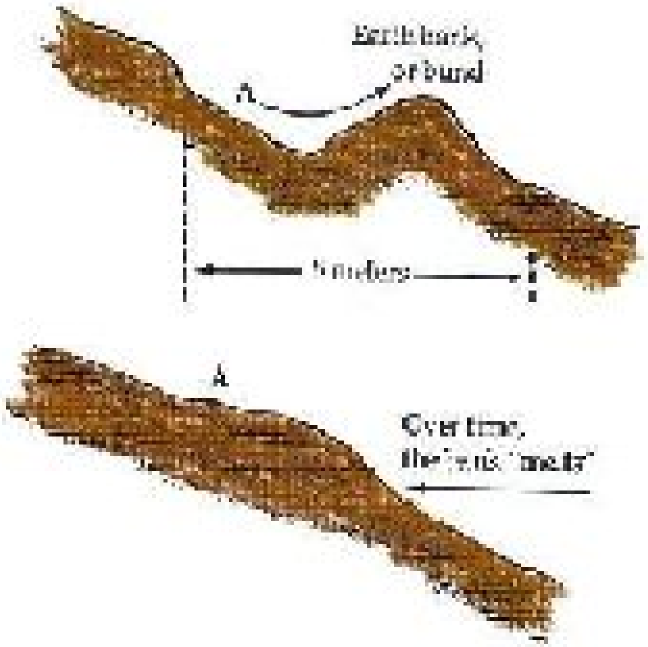
Special Genetic Features

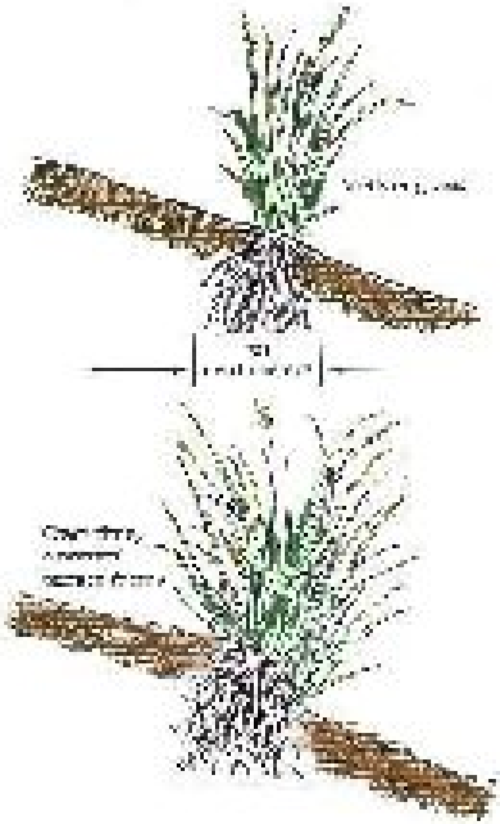
- **Sterile, it flowers but set no seeds**
- **No above or underground runners**
- **As a C4 plant is is sensitive to shading**
- **Non invasive**

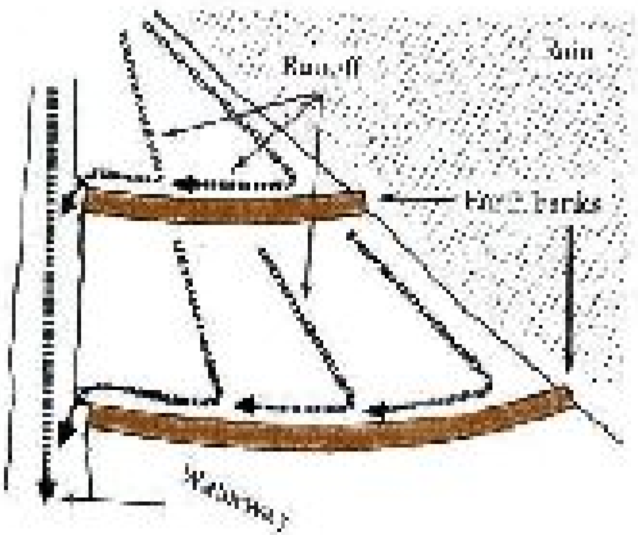
APPLICATIONS OF THE VETIVER SYSTEM

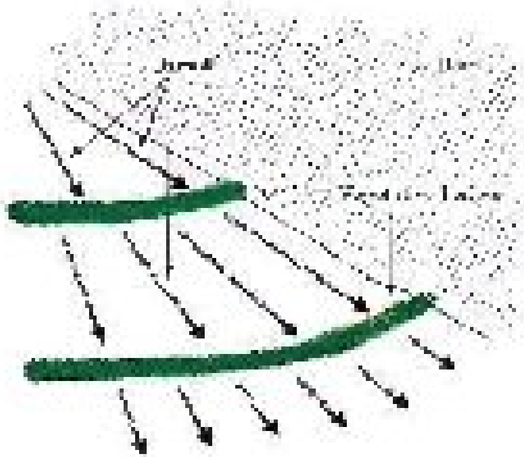
IN SOIL AND WATER CONSERVATION

IN AGRICULTURAL LANDS









LHS Contour terraces are costly to build and maintain, take up more land for the terraces and waterways and do not conserve water

RHS Vetiver System is cheaper to plant and maintain, wastes no land for waterways and conserve soil moisture

SOIL AND WATER CONSERVATION AND CROP YIELD ON 1.7% LAND SLOPE IN INDIA

	Runoff (% Rainfall)	Soil loss (t/ha)	Grain yield (t/ha)
Control	23.3	14.4	2.52
Vetiver System	15.5	3.9	2.88
Changes	Reduction – 35.5%	Reduction 72.9%	Increase 14.2%

SOIL AND WATER CONSERVATION AND CROP YIELD UNDER VETIVER SYSTEM ON 6% LAND SLOPE IN NIGERIA

VS Effects	% Changes
Runoff Reduction	-130
Soil Loss Reduction	-70
Soil Moisture Increase	+ 2 - 50
N Use Efficiency Increase	+ 40
Grain Yield Increase	Cowpea: 11 – 26t/ha Maize: 50t/ha

VETIVER SYSTEM FOR STRIP CROPPING ON THE FLOODPLAIN IN QUEENSLAND, AUSTRALIA

INTRODUCTION

Flooding is a regular occurrence on the floodplains of the Darling Downs, Queensland. Under the natural conditions of tree and grass cover, flood waters were spread out over the floodplains and caused little damage.

When these areas opened up for cropping, most of the natural vegetation was removed, roads and fences were constructed and crops were grown in square or rectangular paddocks.

These changes resulted in the diversion and concentration of floodwater into fast moving flows that caused crop damage and soil erosion, and seriously affected the productivity of this valuable area.

To reduce the damage caused by floods, management practices have been developed to keep the water spread out and slow moving as occurred naturally

STRIP CROPPING

Hector Tod a local farmer pioneered the use of Strip Cropping in Australia, which is a soil conservation technique used by farmers on non irrigated on the floodplains of Australia. These floodplains have very low gradient slope (maximum slope 1%) which is subject to periodic, major overland flows in the rainy season.

Strip cropping involves farming the land in strips of equal width, where the strips are positioned perpendicular to the flood water flow.

The success of strip cropping significantly depends upon the crop rotation system. The crop rotation provides agronomic advantages such as reduction in disease and insect problems, better use of soil moisture and improved soil nitrogen through the inclusion of legumes. In terms of soil erosion, the sequence of crops and crop stubbles is essential for strip cropping to be an effective soil conservation technique.

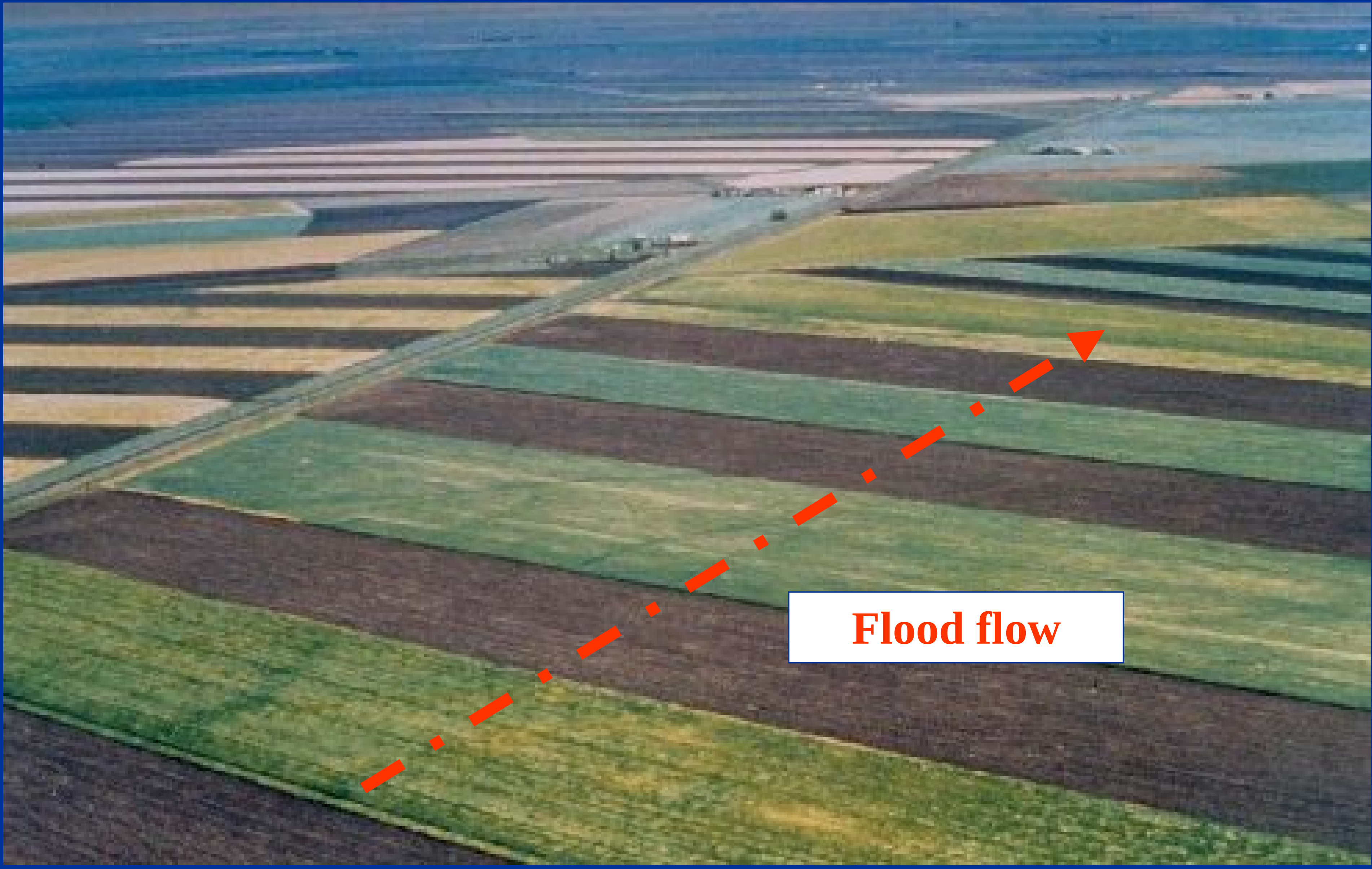
STRIP CROPPING (continued)

The principal aim of Strip Cropping is to protect the fallow land, forcing the flood waters laterally thereby reducing the depth and velocity of flow, which prevents erosive velocities occurring in the bare or unprotected strips. The overall effect being a reduced velocity of flow over the unprotected strips. Prior to strip cropping flood flows were concentrated and rapidly runoff the land, whereas under strip cropping practice, flows across the strips are spread and slower, thus reduce erosion and allowing more time for infiltration.

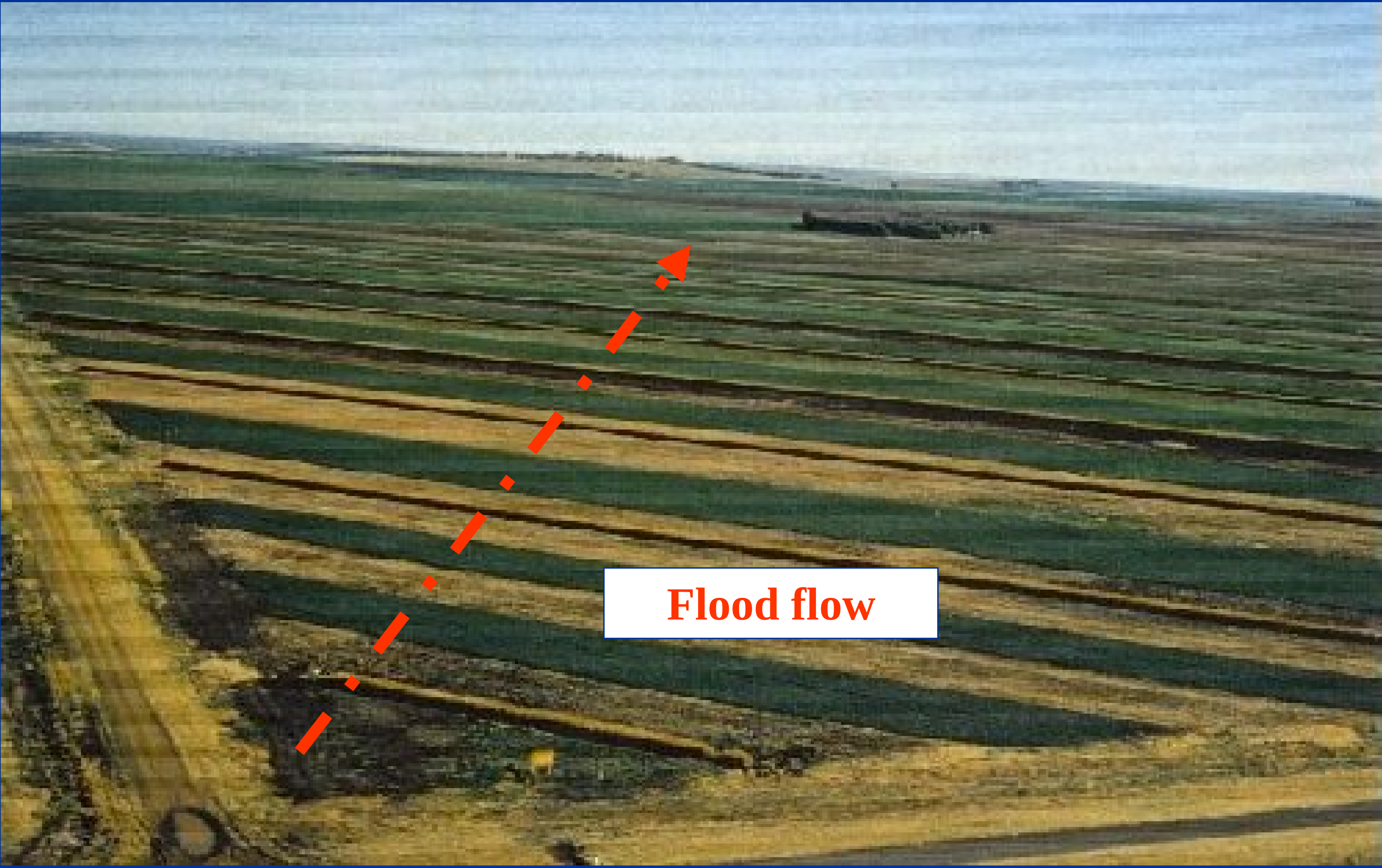
However one of the main shortcomings of strip cropping is that during drought, crops cannot be grown to protect the floodplains from flash overland flooding, which often occur early in the wet season.

During prolonged drought in eastern Australia in the 1990's large areas of the floodplains had no residual cover from previous crops, or any growing crops, hence extensive areas were exposed to potentially serious erosion.

In Strip Cropping, crops are planted on the contour in a sequence of crop, stubble and fallow strips perpendicular to the flood flow



Experimental site before Vetiver planting



Application of the Vetiver System on the Floodplains

The drought and the increasing dryland cotton farming have exposed the floodplains to increased erosion. With the above extraordinary attributes,Vetiver was grown on the floodplains in an effort to provide protection in erosion sensitive areas.

It was grown in associations with existing strip cropping layouts so that the beneficial characteristics of the two systems can compliment each other.

Vetiver grass planted in the concentrated flow areas is also proving to be effective in aiding the siltation and stabilisation of those areas.

Mechanical structures are often ineffective on the Vertisol on the floodplains, those structures built on these soils have generally failed. These structures have been costly to build, to maintain and the resultant damage has been extensive when they have failed. Vetiver grass is proving to be cheap and effective.

LANDHOLDER PERCEPTIONS AND EXPECTATIONS

Aims of farmer:

Improve and protect land condition by erosion control and water harvesting. Ultimately 15-20% increase in yield can double profit - 50% of profit from tradional overland flow 'irrigation‘.

Vetiver grass would control erosion at all times, even in drought conditions when no crops can be grown. Good strong hedge will slow and spread water and give better water infiltration and small benefit from wind protection.

As vetiver hedges provide a permanent protection measure to crop and soil erosion. Farmers can use the whole area for opportunity cropping and hence increase productivity by 30%

Disadvantages: loss of yield up to 2m from hedge in adjacent crops, harbor some pest, sensitivity to Glyphosate use in minimum tillage, wash outs in weak spots and labour intensive to establish

FARMER SUGGESTIONS FOR FUTURE IMPROVEMENT

- **Need to develop mechanical planter to save on labour, speed up planting operation**
- **Widen strips**
- **Keeping hedges slashed may reduce erosion problems where water breaks through**
- **Keep hedges to a height of less than 500mm may reduce yield loss caused by shading.**
- **Need to earn some return from the hedge such as essential oil and sale of planting material**

As vetiver hedges provide a permanent protection measure to crop and soil erosion. Farmers can use the whole area for opportunity crops and hence increase productivity by 30%

Research and Development

Extensive R&D were conducted to determine the specific design for the experiment site.

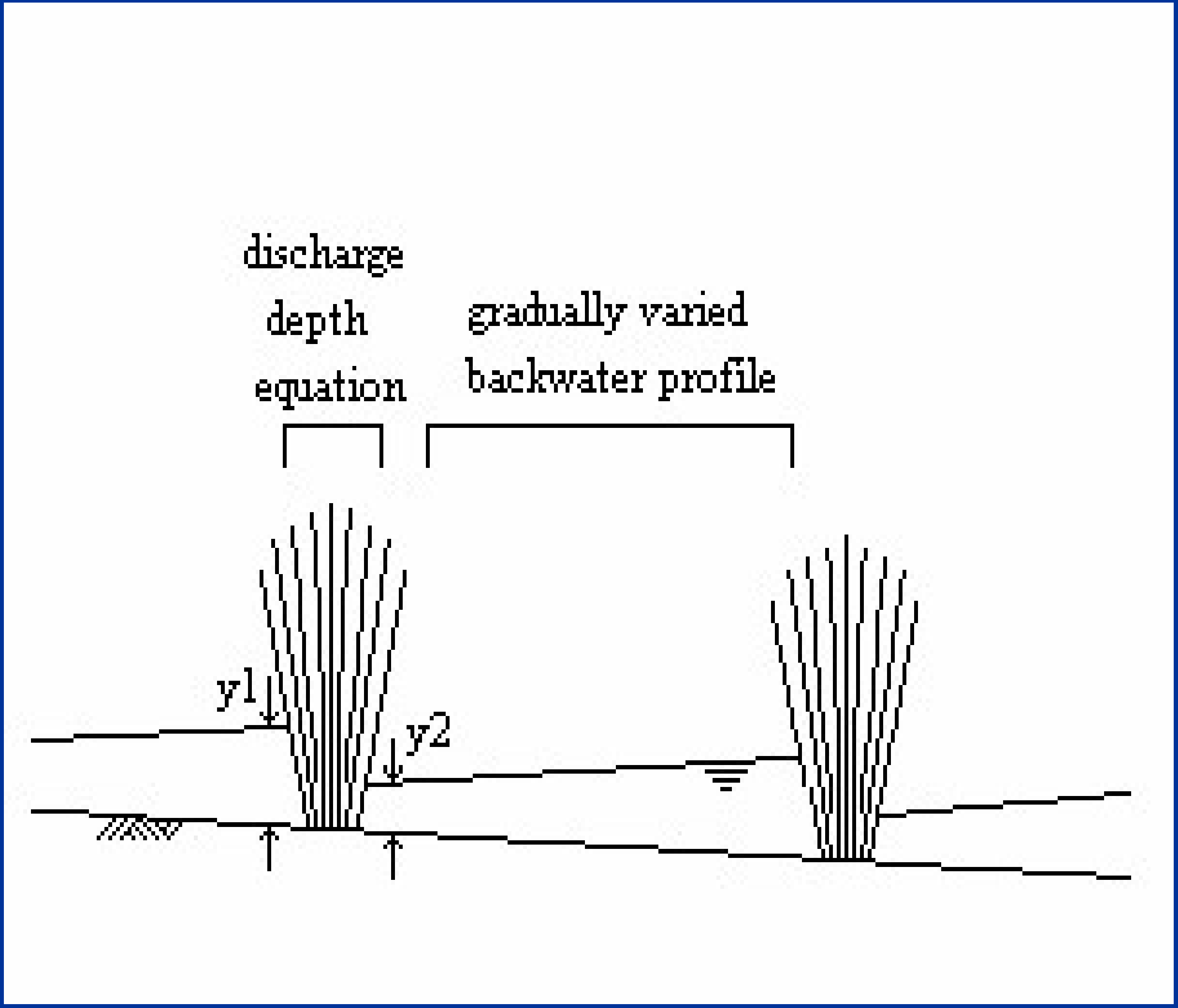
Important results of a paper entitled: Vetiver Hedges: *An Engineering Design Approach to Flood Mitigation on a Cropped Flood Plain by* Paul Dalton, Rod Smith and Paul Truong, are presented below:

- **Trials aimed at a quantitative description of the hydraulic characteristics of vetiver grass hedges are described. Three hedges were planted across a large outdoor flume, perpendicular to the flow. Trials were conducted at various discharges and depths and the discharge and depths upstream and downstream of each hedge were recorded.**

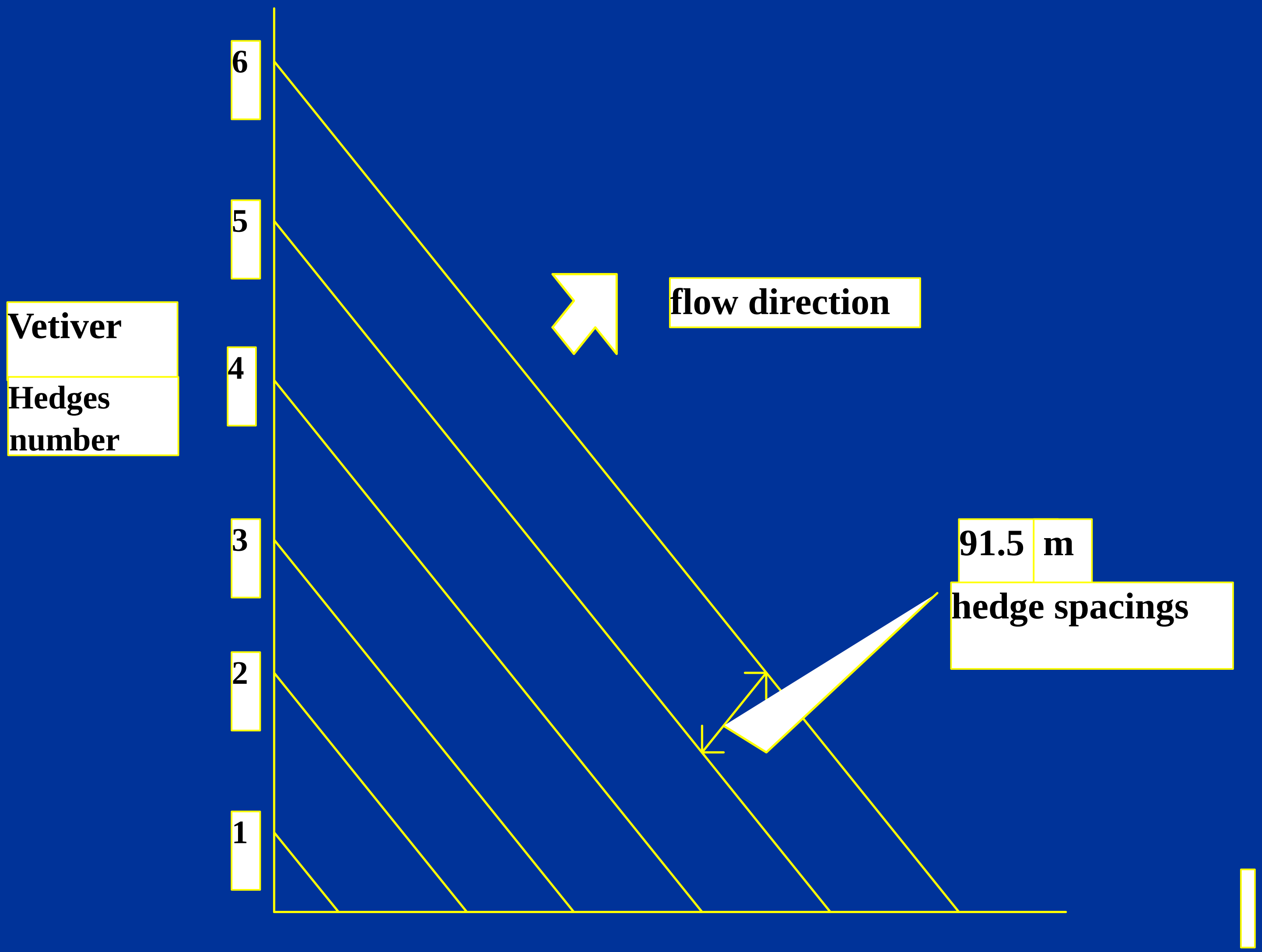
Research and Development

- **From this data an empirical hydraulic relationship was developed between the depths and the discharge. This relationship was used to calculate the maximum vetiver grass hedge spacing required to control soil erosion on a cropped flood plain of low slope subject to deep erosive overland flows.**
- **Finally an appropriate hedge spacing was calculated for a field site. Hedges were planted at the appropriate spacing and flow retardance and sediment trapping were monitored**
- **It is hydraulically feasible to use vetiver hedges to control flood flow and erosion on a cropped flood plain.**
- **Vetiver grass hedge spacings are effective up to land slopes of 2%. At this land slope and beyond the design for vetiver hedge spacing would require a different model of flow**

The physical model of flow over bare fallow and through vetiver hedges



The layout of hedges spacing on experimental field site

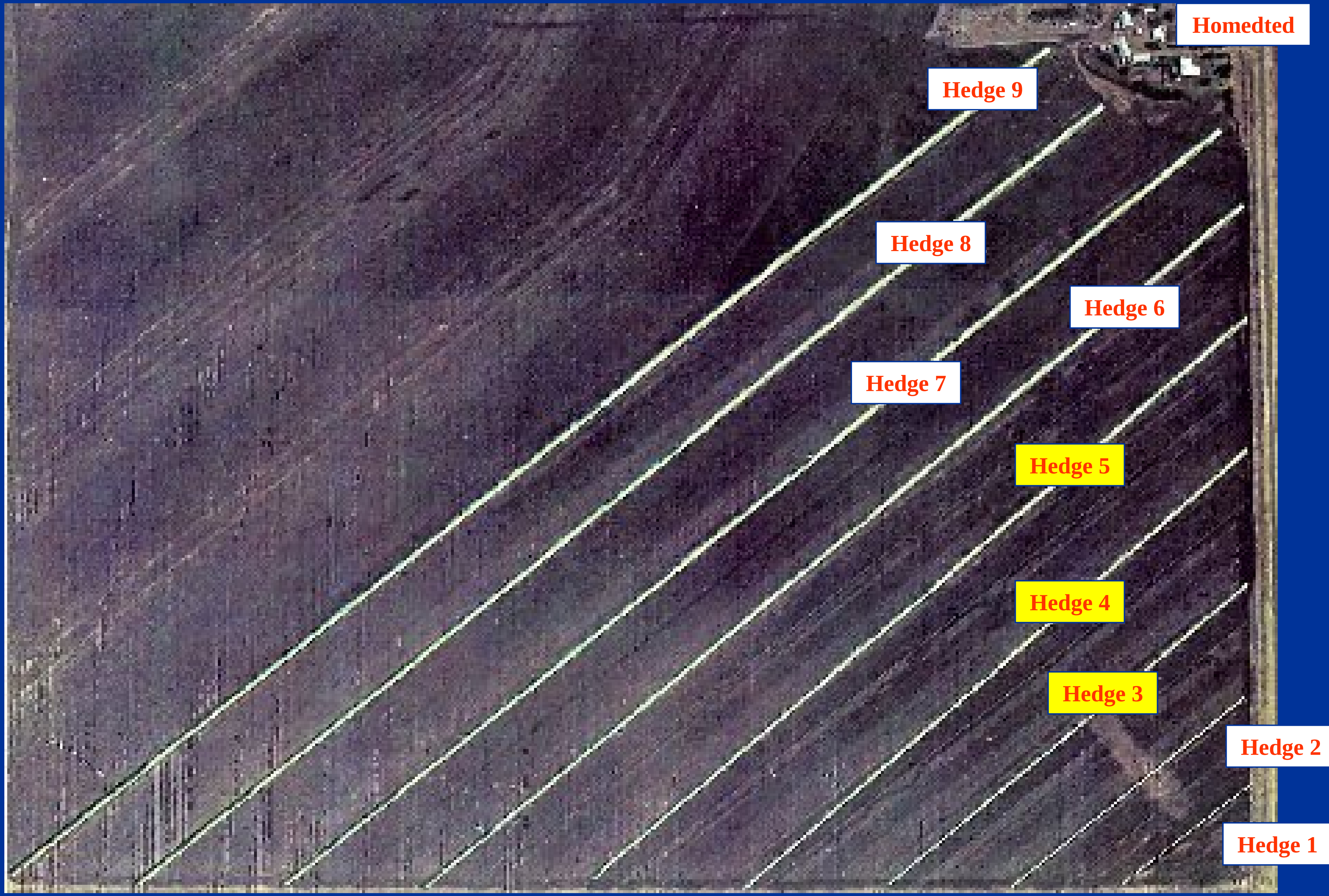


Depth and velocity recorded of the February 1995 flood at the field site.

Vetiver Hedges number	Upstream Depth (m)	Downstream Depth (m)	Upstream Velocity (ms^{-1})	Downstream Velocity (ms^{-1})
3*	0.285	0.197	0.376	0.243
4*	0.341	0.241	0.217	0.325
5*	0.344	0.319	0.343	0.343
* As shown on next slide				

Note that all parameters: Upstream and Downstream Depth and Flow Velocity increase downslope, indicating that downslope hedges are very effective.

Location of hedges on experimental site



Outdoor flume for experimental testing

Outdoor flume for experimental testing

Outdoor flume for experimental testing

Outdoor flume for experimental testing

Note different water level before and after hedge

Testing different flow velocities

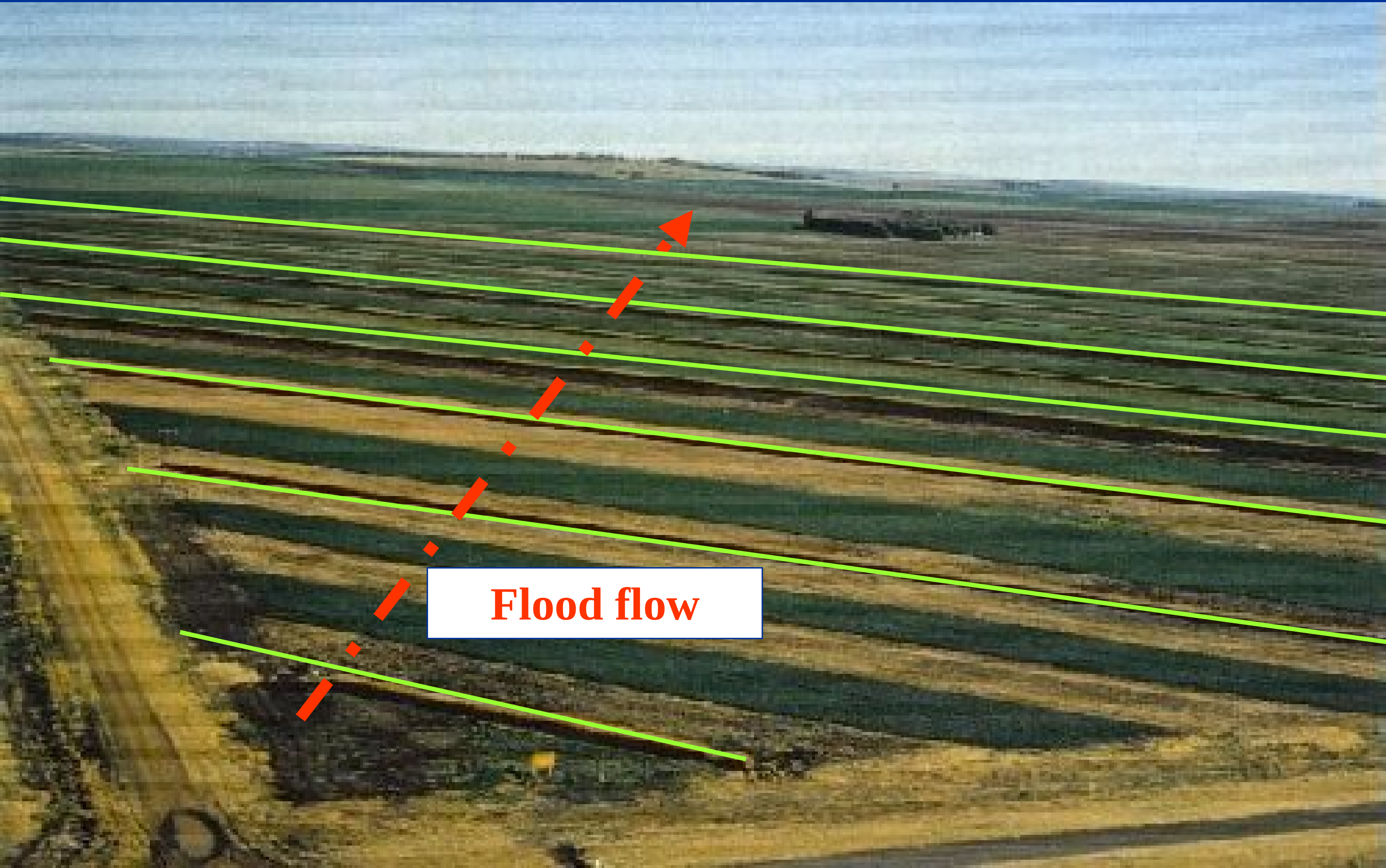
Hedge frosted in winter and new planted crops in spring

Hedge greens up in summer with mature cotton (L) and sorghum (R)

Regrowth of after fire to controll mice hinding in winter

Fire only burnt center of hedge

Experimental site: Six rows of vetiver planted at 90m interval, equivalent to 4 strips of 22m wide each.



A major flood event in 1995

No sign of rill and minimal surface erosion on both sides

Trapping sediment on upslope side of some hedges

No flood damage and excellent crop of sorghum

Opportunity cropping:
No need for fallow and stubble strips

Monitoring Gages

To record the hydrological and sedimentation data two instruments were used:

- Velocity Headrod to record flow velocity and flood depth

- Sediment plate to record sedimentation at upslope and downslope of hedges

Velocity Headrod

Velocity Headrod placement at upslope (L) and downslope of hedges (below)

Velocity Headrod after flood

Sediment plate placement at upslope and downslope of hedges. Before and after sediment sample was collected


Vetiver Trapping Power
THANK YOU
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