THE POTENTIAL OF PALM (BORASSUS) MAT GEOTEXTILES AS A SOIL CONSERVATION TECHNIQUE

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1 INTRODUCTION

Water erosion is a major global issue, responsible for 56% of worldwide land degradation (UNEP, 2002). Estimated soil loss ranges from 6 billion tonnes per year in the USA to 90 million tonnes per year in Australia, with greater losses in Africa (Hudson, 2001). The loss of valuable productive topsoil impacts food production and threatens security, particularly in the developing world. UNEP (1992) forecasted that by 2025, 83% of the world's estimated 8.5 billion population will be living in the developing world and there is an uncertainty as to whether available resources and technology could satisfy food demands. A major objective is to increase food security through the development of appropriate new technologies that are sustainable, available and economically-affordable to rural communities in developing countries.

2 RATIONALE

One method used for soil conservation is geotextiles. Geotextiles have contributed to the erosion control industry for over 50 years (Dayte and Gore, 1994) and are mainly used in civil engineering projects, such as dam retaining walls, bases for roads and reservoir slope stabilization (Davies, 2000). Their use prevents off-site effects, such as silting-up of watercourses that can result in flooding and water pollution by nutrients and pesticides (MAFF, 1998). Water erosion can also contribute to landslides, endangering life and property (Hudson, 2001). Inappropriate land management, including the lack of maintenance of vegetation cover, is one of the causes of gully erosion (Casal et al., 1999). By removing vegetation cover the erosion-resisting capacity of the soil becomes disturbed. The kinetic energy of raindrop splash increases, resulting in increases in soil detachment. Hydraulic surface flow increases with the lack of vegetation cover, which also increases soil susceptibility to erosion, by reducing cohesion and shear strength (Rickson, 2001). Management strategies should aim to improve soil physical and hydrological properties (Fitzgerald et al., 1998). On a near-vertical slope, to provide protection at the foot of a steep shale slope, engineers used cellular confinement to promote vegetation cover and prevent erosion (Hogan and Zeinert, 1998).

Although synthetic geotextiles dominate the market, natural fibres such as coir, sisal, ramie and jute also have geotechnical applications. Recent studies have shown that natural fibres are more effective than synthetic in controlling erosion (Sutherland and Ziegler, 1996) and were the preferred method in a study at a wildlife refuge, because of their 100% biodegradability and better adherence to the soil (Langford and Coleman, 1996). However, in developing regions, commercially marketed materials are too expensive (Gumaa et al., 1998).

Geotextile mats were constructed from the leaf of Borassus aethiopum, in a small cottage workshop in The Gambia, West Africa (Plate 1). The leaf was stripped and the central spines removed, soaked in water to make the material pliable and then woven into 50 x 50 cm (2500 cm2) squares. The spines were made into pegs, to hold the mats to the soil.

Plate 1: Construction of palm mats, June 2001, The Gambia, West Africa

Palm leaf geotextiles could have considerable benefits for developing countries, because:

The material is readily available.

It is sustainable, if harvested correctly

The mats are simple and cost-effective to manufacture, without the need for high-energy production procedures.

They could provide employment in rural environments for women, disabled and disadvantaged people, contributing to the stabilization of rural populations.

Being biodegradable, they may increase soil fertility and organic matter.

They will provide immediate erosion control, as they mimic the properties of vegetation cover (Rickson, 2001).

They encourage sustainable and environmentally-friendly palm agriculture.

They encourage reforestation and agroforestry and discourage deforestation.

The export of completed palm geotextiles to industrialized countries will earn hard-currency for developing economies and develop the principles of fair-trade.

Extensive reviews suggest that palm leaf is not currently used in the geotextile soil erosion control industry. After Cocos (coconut), Borassus palms are the most widely

distributed of the Palmae and have been used extensively for over 6,000 years, providing over 800 resources for human use (Davis and Johnson, 1987). Preliminary investigations suggest that the use of palm mat geotextiles could be an effective and cheap soil conservation method, with enormous global potential. When compared to geotextiles already on the market, costing of palm mat geotextiles shows that at $0.30-0.55 per square metre, the mats are economically viable (Table 1).

Table 1: Guide to geotextile prices

Application	Price
	US $ per sq metre
Erosion Control	
Synthetic	1.00 - 3.00
Woodfibre/Straw	0.55 - 1.10
Jute	0.30 - 1.00
Coir	0.90 - 2.20
Agro-mulching	
Plastic film (not geotextile)	0.10 - 0.25
Un-paved roads/separators	
Synthetic	3.00 - 5.00
Jute	0.60 - 1.00
Coir	0.90 - 2.20

Source: Smith, 2000

3 METHODS

The objectives of this project are to construct geotextile mats from the leaf of Borassus aethiopum (Plate 2) and test them in field and laboratory conditions, to evaluate their long-term effectiveness in controlling soil erosion through runoff and soil splash detachment. The study includes an evaluation of effects of the mats on soil chemistry and structure and assesses their sustainability and economic viability. A three-month pilot study has already been conducted on the potential of these mats at the Hilton Experimental Site, Shropshire, U.K. Davies (2000) found the mats decreased sediment yield by 95% in field studies and 99.9% in laboratory investigations on a rainfall simulator at Coventry University, compared with bare soil. On the basis of these results, a Ph.D. study is using the Hilton Site and laboratory facilities at Coventry University.

Plate 2: Palm mat geotextile

Eight 10 m2 runoff plots, on a 15o southwest facing slope, are being used for the field study. Duplicate plots are bare soil (control), grassed, completely covered with palm mats and with 1 m buffer zones at the lower end of the plots (Plate 3).

Plate 3: Hilton Experimental Site, Runoff Plots

Splash erosion studies are also being conducted on the base of the west-facing slope at Hilton. Laboratory studies using a drip-screen rainfall simulator will enable controlled observations of the sediment yield from runoff and splash detachment under varying rainfall intensities. To evaluate treatment effects, soil pH, nutrient status, structure, infiltration properties, organic content and mat tensile strength were assessed prior to the study commencing and will be repeated on completion of field investigations. Field observations are being made on the integrity and drapability of the mats.

A ‘time and motion’ study was conducted in The Gambia during the construction of the mats, to assess their economic viability. Sustainability will be assessed through literature reviews and consultation with forestry departments throughout Africa, Asia, South America and the Caribbean. In the next experimental phase, field and laboratory studies will be initiated throughout a network of collaborating partners in Australia, Barbados, Brazil, China, Cuba, The Gambia, Hungary, South Africa, Thailand and the U.K.

These studies will be conducted under a variety of climatic, environmental and socio-economic conditions.

4 CONCLUSIONS

Geotextiles create a stable, non-eroding environment that provides the time necessary for vegetation to establish and grow (Rickson, 2001) and, if constructed using indigenous materials, can be effective and affordable in a way that is compatible with sustainable land management. Although the primary aim of the study is to investigate the potential of palm mat geotextiles as a soil conservation technique for sustainable agriculture, there is potential for off-site soil stabilization. The mats may have the potential to conserve soil in specific targeted applications, such as gully control on slopes that have been urbanized for dwellings by the more marginalized in society. These urbanized hillsides are prone to mudslides and flooding, resulting in not just environmental damage but also loss of life. Palm mats could become a feature of multi-faceted projects aimed at preventing further erosion, providing direct employment through reforestation of gullies and hillslopes and resulting in improved environments for those living in these precarious conditions.

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