LAND FORMING ON FLAT CLAY SOILS FOR IMPROVED SUGARCANE YIELDS

JM GOSNELL[1], R YEATMAN[1], *T BESTER[1] AND JW HESTER[2]

[1] *PGBI International, 8 Wolseley St., Woodmead 2128, South Africa, info@pgbi.co.za*
[2] *John W Hester and Associates, Shelby, Mississippi, USA*
** To whom enquiries should be addressed*

Introduction

Surface drainage is often a problem on heavy black montmorillonitic clays with very flat grades that are typical of several Mozambican deltas where sugarcane is grown under high rainfall conditions. Widespread ponding of surface water can cause substantial reduction in cane growth, often resulting in yields of below 60 tons cane per hectare, far less than the expected yield levels.

Principles of land forming

Land forming is the process of creating grades, typically around 1:1000, to allow run-off of either rainfall or irrigation water within 24 hours. An important requirement is that there must be no reverse grades such as often occur during construction of the tail drain at the bottom of the field. Land forming must be supported by the construction of adequate tertiary, secondary and primary drains and drain-pumping where required, if the full benefit of the investment is to be derived.

Where existing fields are land formed, the current infrastructure will largely dictate the field layout and direction of the grades. In new areas of land, it is advisable to undertake a pre-engineering survey and develop a conceptual plan to establish the field layout and the locations of the major canals, drains, roads and other infrastructure.

Land preparation

Land forming is preceded by land preparation that can include normal bush clearing and de-grassing, removal of cane stools and rough leveling of variable micro-topography, e.g. caused by gilgai or existing camber beds.

In Mozambique, grass/reed growth is prolific and if not destroyed will reduce the capacity of the land forming equipment. To achieve this, one technique is to use two heavy tractors towing an anchor chain between them to flatten the grass after which it is cut with a disc harrow set with discs parallel, and then burnt when dry. Alternatively, a glyphosate spray can be used to kill the grass (e.g. Roundup at a rate of 6-8 litres per hectare); the choice is determined by cost.

It is common for rough leveling to be carried out with a bulldozer and grader or land plane and cane stools to be removed with a V-plough.

Land forming operations

After completion of the land preparation activities, a 30m x 30m grid field survey is carried out using a Total Station. The results are downloaded into specialised proprietary computer software that optimizes the cut-and-fill soil volumes and minimizes not only costs, but also the risk of 'scalping' into the subsoil.

Land forming is normally carried out with large 250 kW 4WD articulated tractors on dual wheels towing single or tandem 10 to 14 cu yd laser-controlled carry-all scrapers. Single or multiple passes with a large 50 ft land plane or bottomless scraper is used to finish the land forming process. It is advisable that the final pass is made in the direction of the cane rows to optimize drainage.

The main and field irrigation canals and drains are also constructed during the land forming operation. As the same equipment is used, it is important to integrate the cut-and-fill design in order to minimize soil movement. This generally ranges from 500 to 700 m^3 per hectare, depending on the topography of the fields.

Experience overseas shows that a maintenance program is desirable after each crop cycle. The need for this maintenance is due in some degree to settling in the fill areas over time. The fields can often be brought back to the desired gradients by ploughing followed by a land planing operation. Alternatively, actual cut and fill operations would be required but these would be minor in scope, typically 150 to 200 m^3 per hectare.

Table 1 depicts the typical land development operations with the machine hours required for land forming based on 650 m^3 of soil moved per hectare.

Irrigation

On heavy clay soils, surface irrigation is preferred to overhead irrigation as water penetration is better. The capital cost of overhead systems, as well as unreliable and expensive power, also militate against the latter.

Grades of 1:1000 are typically used for row crops although flatter grades of up to 1:2000 are successfully used on sugarcane in the Ord, Western Australia. The gradient should be based on a plan of the desired row directions as determined by the topographic lay of the land. The specialised software can provide a 'Gradient of best fit' for the subject field.

Row lengths can vary from 1000 m (or more) to 100 m and are determined by local operational requirements. Shorter lines may reduce cut-and-fill and are more forgiving but will increase land wastage and labour usage. For cane fields, row lengths of 200 to 300 m are common practice and have proved to be both practical and efficient with regard to irrigation and cane harvesting.

Table 1. Land development typical operations.

Description	Tractor & Equipment	Hours/ha
Bush/Grass clearing	D7, anchor chain	variable
Rough leveling	D7	1.5
	Grader 140G	1.3
Level camber beds	Grader 140G	4.5
Rome plough	250 kW	0.8
Disc harrow	160 kW	0.4
Cane stool ploughing	70 kW	2.0
Remove roots/stools	70 kW + trailer	4.0
	Labour man-days	30
Land plane	160 kW	0.5
Land forming	250 kW + carry-all scrapers	5.0
	160 kW + bottomless scraper	1.0
Chisel plough	160 kW	0.7
Disc harrow	160 kW	0.4
Ridging	70 kW	1.2
Tidy up	Grader 140G	2.0

Note that the above table does not include construction of canals, drains, night storage dams and other infrastructure.

Row spacing should be related to track width of cane transport and other infield equipment; 1.8 m is preferable to narrower spacing because of the negative impact of compaction on these soils. The use of dual rows at the wider spacings is still being evaluated under field conditions.

Benefits

The application of these principles has enabled farmers in the Ord to consistently achieve yields of over 130 tons cane/ha on very flat heavy clay soils using furrow irrigation. PGBI International has pioneered laser-controlled land forming on heavy black montmorillonitic clays in Mozambique in 2000 and is continuing with further operations in 2001. Initial indications are encouraging – detailed performance figures will be available in 2002.

Acknowledgements

The authors express their gratitude to Messrs J Clark, General Manager, and G Barry, Agricultural Manager, of Acucareira de Mocambique SARL for their co-operation and to S Kelly and B McConnell of CLM Civil Contractors Ltd, the plant hire contractors.