MULCHING WITH GRASS AND PLANTAIN TRASH AND ITS EFFECT ON CROP AND SOIL CONDITIONS*

INTRODUCTION

IN 1925, after a decade of clean weeding in permanent crops in Uganda, it became evident that the practice had very grave disadvantages under Uganda conditions. All too frequently, erosion was severe and the soil was "dead," having lost all its organic matter. Coffee yields were on the average very low, and areas which did set a big crop invariably suffered from dieback, associated with *Hemileia*, and failed to ripen all the crop. As a result, the Department called attention to the dangers of clean weeding on account of the erosion which was taking place, and an artificial mulch was advocated.

THE SOIL MULCH

The basic idea behind the practice of mulching was one of conservation of moisture, the original and most widely advocated mulch being what was known as a dust mulch. This is a misnomer because all that is intended is that the soil shall be cultivated after each rain to break the capillaries and prevent undue evaporation from the surface. Experiments were made to prove this, and the soil mulch became a standard practice under dry-farming conditions. In fact, the aim of the clean weeding programme in plantation practice was the production of a soil mulch which, by reducing weed competition and direct evaporation undoubtedly does conserve moisture, but Keen, Shaw and others have shown that there can be no capillary rise of water to take the place of that used by the crop unless the water table is within six feet of the surface.

Continual cultivation is needed to keep a soil mulch intact, with the result that the soil of the mulched layer is never used by the roots. The top six inches of soil is normally the most fertile, and under mulching conditions is not available. The continual cultivation also means loss of humus, particularly under tropical conditions, and loss of humus invariably means loss of texture and water-holding capacity. Under tropical conditions, too, the maintenance of a light loose top layer of soil is very expensive, and serious erosion must follow.

ARTIFICIAL MULCHES

Artificial mulches are formed by the application of straw, chaff, peat, leaves, sawdust, stones, or other material on the surface of the land. Most

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* By W. S. Martin, M.Sc., Ph.D., A.R.C.S., D.I.C., A.I.C., Agricultural Chemist, Uganda, in *The East African Agricultural Journal of Kenya, Tanganyika, Uganda and Zanzibar*, Vol. I., No. 2, September, 1935.

authorities on soils dismiss this method, because of the expense attached and labour involved, but admit that such mulches are very effective. In calculating the costs they seem to have omitted the tremendous and continuous expense attached to the upkeep of a soil mulch, which should be deducted from the gross cost of an artificial mulch. Very little scientific work on artificial mulches has been carried out, but the following records are interesting.

An experiment at Cornell University to estimate *The Cause of Injury to Maize by Weeds* by Craig in 1908 included a straw mulch treatment, and the results were:

TABLE I

Treatment	Yields calculated to basis of 100 on controls	Soil moisture per cent. during August
		Per cent.
Control ...	100 ...	21·1
Weeds removed but not cultivated	96 ...	18·2
Mulched with straw ...	121 ...	25·0
Control ...	100 ...	18·2
No cultivation weeds allowed to grow	31 ...	9·8
One cultivation weed allowed to grow	98 ...	17·7
Control ...	100 ...	17·7

Here the mulched plot gave an increase of 21 per cent. in yield, and an increase of more than 5 per cent. moisture on the mean control. Unfortunately, there were only single plots of the treatments, and the work was not followed up. Albrecht, publishing in 1922 and 1925, working solely on the nitrate and moisture effects of straw mulching, reported a decrease in nitrates and an increase in moisture under a straw mulch. He also noted that the soil under a mulch became plastic, sticky, and of poor tilth, and suggested that the lower nitrate formation was due to lack of aeration, low temperature and too much moisture.

Beaumont and others published in 1927 and 1933 an experiment on straw mulching in orchards, in which the first samplings after the mulch application showed a decrease in nitrate, but after three years of continuous mulching the nitrates increased over the control. This was explained on the C/N ratio of the lower layers of mulch. No mention is made of yields or of any change in soil texture in this case.

In 1914, in Hawaii, on a sugar plantation, a light tarred or asphalted paper was spread directly over the rows of seed cane and harvested stubble as a measure of weed control. In the middle of the rows, between the sheets of paper, cane trash was used as a mulch. No yield records are available, but the advantages of the practice were so obvious that it was extended to pineapple production. Here records were kept of moisture, temperature, and nitrate content of the soil, all of which showed an increase as a result of mulching.

The value of a mulch as an anti-erosion measure is self-evident from a purely mechanical standpoint, but experiments by Lowdermilk, of the Forestry Research Station, California, have led to an interesting theory which fits the facts. The suggestion is that the force of the rain on reaching the soil is sufficient to detach the clay particles, so that the liquid percolating is muddy and tends to clog the soil pores. To prove this he percolated ordinary soil first with clear water and then with muddy water. The result was a 90 per cent. diminution in percolation within six hours of using the muddy water, and the drainage water was still clear. On reverting to clear water percolation rate did not improve. Anyone who has seen puddles during rain on cleared land must have noticed that the water is muddy and the fact that muddy water reduces percolation and enhances the possibility of run-off is proved. Any sort of artificial mulch will protect the surface soil from the force of the rain and reduce the chances of a muddy percolating liquid.

TRIALS IN UGANDA.

PERMANENT CROPS.

The main objection to mulching on European estates is the cost. This varies with the density of the grass cut and the distance it has to be carried. Plantation costs have varied between Sh. 10 and Sh. 60 per acre. In a few instances, where lorries were used, the costs were over Sh. 100 per acre. To attempt to put the question on an economic basis an elaborate 8 × 8 Latin square experiment was laid down on Mr. Stafford's estate at Hoima. The treatments were:

TABLE II

The Effect of Mulching as Compared with various Fertilizers

Treatment	Yields of Cherry in Cwt. per acre									
	A	B	C	D	E	F	G	H	Mean	Significant difference
Yield	3·61	6·1	3·27	7·0	5·92	6·08	6·65	18·1	7·09	4·14
Percentage of mean	51·0	86·1	46·1	98·8	83·5	85·8	93·8	255·3	100	58·5

		Per acre
A.	Sulphate of potash	2 cwt.
B.	Superphosphate	2 cwt.
C.	Control	—
D.	Diammonphos	180 lb.
	Sulphate of potash	2 cwt.
E.	Superphosphate	2 cwt.
	Sulphate of potash	2 cwt.
F.	Diammonphos	180 lb.
G.	Cotton seed	3 tons
H.	Elephant grass mulch	12 ins. deep

Here the mulch gave more than double the yield of either cotton seed or Treatment D—a complete, easily soluble, artificial manure, so that the mulch can bear at least twice the cost of application of any other fertilizer. The actual difference between the mean mulch yield and the mean control is 2.3 cwt. of clean coffee, which at Sh. 40 per cwt. on the estate amounts to Sh. 92, and on this estate the mulch cost was Sh. 63 per acre—a net gain of Sh. 29 per acre, without deducting weeding costs from that of the mulch.

An experiment was laid down at the Government station at Bugusege in 1928 on a 5 × 5 Latin square with the following treatments:

A.—Clean weeding.

B.—Green manure (two crops a year).

C.—Banana leaf mulch.

D.—Weed cover.

E.—October to March cover.

The results to date show the treatments A and C are significantly better than the others, whilst treatment E is better than B and D. The picking season of C is longer than that of the other treatments, but 80 per cent., of its crop was picked within a period of one month.

TABLE III

Effect of Ground Treatment on the Yield of Coffee

	Yields in lb. of Cherry					
	1930	1931	1932	1933	1934	Total
A	190	408	3,731	2,789	1,512	8,630
B	184	315	3,713	1,702	1,202	7,116
C	168	390	4,211	1,988	1,760	8,517
D	205	255	2,844	1,909	558	5,771
E	192	405	4,465	2,290	493	7,845

There are indications that mulching is giving a more even annual crop, as opposed to the big fluctuations normally met in Uganda.

A combined field and laboratory experiment is being carried out to test the effects of various ground treatments on soil moisture, temperature, and nitrate content. The treatments are: (a) Clean weeded; (b) Cover crop (*Centrosema pubescens*); (c) Weeds slashed; (d) Mulch. The experiment has been running for nearly two years, and it is definite that the soil moisture under a mulch is much higher than the other treatments, and the temperature lower. For the first year of its growth the cover crop was the driest, but afterwards it recovered, and at the time of writing it is almost as moist as the soil under mulch. Nitrates under mulch and cover crop are both lower than in the clean weeded plot. There are also indications that some soil types under mulch tend to become sticky and plastic, as recorded by Albrecht. Up to the present there is no acidity change, and

the most probable explanation is that under a mulch a soil is not exposed to alternate wet and dry periods, which help to preserve the texture of heavy soils in the tropics.

To combat this tendency, and to reduce mulching costs, alternate row and alternate year mulching was tried at Hoima.

TABLE IV

Comparison of Complete and Alternate Row Mulch

Treatment	Mean Yields of Cherry in cwt. per acre		
	1933	1934	Mean 1933 and 1934
Complete mulch (long grass)	9·2	12·0	15·1
Alternate row mulch (chaffed grass)	4·8	11·7	8·24
Control	4·0	11·2	7·57
Complete mulch (chaffed grass)	5·4	15·7	10·53
Alternate row mulch (long grass)	6·0	18·5	12·25
Significant difference	2·7	6·7	3·79

From these figures it is evident that there is no necessity to go to the expense of chaffing grass, and the complete mulch is not significantly better than alternate row mulch, which can be applied at half the expense and will help the soil to regain texture.

To test the effect of mulch together with other treatments on young coffee an experiment was laid down at Lukumbi, with the following results:

TABLE V

Ground Treatment and Manuring on Young Coffee

Treatment	Mean yields of Cherry in cwt. per acre		
	1933	1934	Mean 1933 and 1934
Cotton seed (3 tons per acre)	17·00	50·43	33·71
Control	11·97	39·30	25·63
Meraco bonemeal (10 cwt. per acre)	17·12	43·71	30·42
Green manure	13·02	38·45	25·74
Mulch	15·60	51·11	33·35
Niciphos (240 lb. per acre)	15·63	48·10	31·86
Significant difference	4·18	7·83	2·11

In this case there was no significant difference in yield between mulch and the two manuring treatments, but the difference in the appearance of the trees was remarkable, in that the trees of the mulched plots carried their crop well and the other plots all showed the typical signs of over-bearing.

PRACTICAL APPLICATION IN UGANDA

It is evident, both from the results of the experiments already given and from actual observation in the field, that as far as Uganda is concerned, mulching is the best treatment for coffee yet discovered. This is particularly true in native agriculture, as with scattered native plots the cost of the mulch is practically nil. The native Arabica coffee-growing industry in Bugishu was in a very poor state in 1930, but after mulching was adopted the industry reached a sound position.

In Buganda, where the main native coffee crop is Robusta, mulching is also being encouraged, and in the drier areas the policy has been to establish coffee only where grass is available for mulching.

On plantations, the difficulties of mulching are twofold—the availability of mulching material and the cost of application. Both difficulties are solved to a certain extent by alternate row mulch, which enables a bigger area to be treated with the material available and at the same time halves the cost. By adopting this policy and by reducing the depth of the mulch one planter has been able to cover over three hundred acres, at a cost of little more than Sh. 10 per acre. Areas in which coffee production would have ceased to be economical through loss of vitality in the trees and soil erosion now produce a paying crop. Many aspects of mulching still require further investigation, such as the optimum time of mulching and the effect of mulch on soil texture. The solution of these problems is a local one, depending entirely on climatic conditions and soil type.