

SCIENCE AND SOCIETY

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CHAPTER TWELVE

THE EFFECT OF MECHANICAL CLEARING AND TILLAGE ON TROPICAL SOILS

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INTRODUCTION

In Nigeria, of the total food production, over 90% comes from the peasant farmers who are about 80% of farming population (Adegboyega, 1988). However, one of the hanging issues in Nigeria agriculture is that the use of manual labour technique by the peasant farmers is perhaps the cause of low food production.

The educated youths believe that tractorization can bring solution to low agricultural production and mass exodus from rural farmlands. Undoubtedly, judicious use of farm machines will make farming more attractive, increase crop output per unit and save time and energy, assist weed control and larger hands will be engaged in agricultural sector to solve the problem of Nigerian food crises through large area of land cultivation.

It was perhaps the hope of the planners in Nigeria that if the 81.2 million hectares of available arable land in the country is put under cultivation, the food production might keep pace with the annual population growth rate. In an attempt to mechanize agriculture in Africa, Agboola and Omuetti (1982) reported that in many African countries, to solve the problem of self-sufficiency in food production, the approach which is often favoured by many farmers is to bring new farm lands into large scale mechanized farming, since the whole concepts of adequate crop production to many of our National Planners is visualized as having a linear relationship with the number of farm machineries thrown into the field. A typical example is the importation of heavy machineries to aid the achievement of Green Revolution Programme introduced in Nigeria by President Shehu Shagari's Government in 1980.

Large scale irrigation projects such as the Kano River and Bakolori projects in Nigeria resorted to the common use of tractors - drawn implements by farmers during land preparation. It was also advanced that farmers may use tractor-drawing implements up to seven times per year on the same land area (Ahmed and Maura, 1988). The mechanical clearing is a good idea except that improper equipment such as bulldozers which are designed to move soils rather than clear forests are often used. For instance, in 1985 over 60% of the mechanically cleared lands were bulldozed and about 2 million hectares were mechanically cleared in Nigeria (Agboola, 1985). The situation is more sympathetic when the tractor operators themselves are not trained on proper land clearing and tillage and also lacking the knowledge about the characteristics of the tropical soils.

CHARACTERISTICS OF TROPICAL SOILS

Apart from geological factors like the type of parents rock, the climatic conditions of an area can affect the physical, chemical and biological properties of a given soil. According to Agboola (1979) the Nigerian forest zone, for instance, is characterized by rapid decomposition and mineralization, low percentage of silicon, high percentage kaolinite and small percentage of montmorillonite, low cation exchange capacity, low available water capacity and low buffer capacity. It can be inferred that the tropical zones are inherently infertile with low nutrients and water holding capacity. It is vulnerable, erodable and can easily be compacted.

Agboola and Omuetti (1982) reported that another detrimental physical property of most of the soils in the tropics is the extensive occurrence of gravel and gravel layers often near the surface which mechanically can impede root development and appreciably reduce the production potentials of most of the soils. These gravel layers occur more commonly on soils that are developed from basement complex rocks. Indeed, poor structu-

ral soil with susceptibility to erosion require proper management during clearing, tillage, planting and other farming operations. Therefore choice of implements becomes necessary in Africa to properly manage the already fragiled African soils.

CHOICE OF FARMING IMPLEMENTS BY AFRICAN TRADITIONAL FARMERS

It is often said that experience is the best teacher and a typical traditional African farmer is almost married to the African soils. He believes that a tractor-experienced soil is gradually losing its potential fertility and productivity status. Consequently, the main production tools are hand tools produced by Africa village blacksmith. These hand tools include axe, cutlass, hoe, spade, shovel, hand shovel, and garden fork. The tools are available and affordable by the peasant farmers.

In the land clearing process, machets or cutlasses and axes are mainly used while hoe, spade, shovel, garden fork are used for tillage operations. For over 100 years, these traditional tools and the farming system are less harmful to the African soils. Trees are pruned and litters are returned to the soil. The clearing is done by selective tree thinning while the cut biomass is disposed off by burning insitu. This approach is the slash and burn agriculture. The clearing is non-exhaustive and leaves appreciable cover on the soil while the surviving trees still maintain a good structural stability. The practice enhances soil moisture conservation, the soil is not completely exposed to high tropical temperature, torrential downpours and turbulent wind. This approach therefore, contributes to sustainable agriculture at the grassroot of the traditional farming system.

EFFECTS OF MECHANICAL CLEARING ON PHYSICAL SOIL PROPERTIES

The use of heavy machinery as means of preparing the fragile soils for agriculture was considered by Greenland and Lal (1979) to be so great that studies on the effects of different clearing methods on the physical characteristics of soil

were most urgently needed.

The soil physical properties that are adversely affected by mechanical land clearing and tillage include: soil structure, bulk density, infiltration, soil temperature, laterite formation and compaction leading to run off and erosion.

Compaction from wheel traffic has been found to influence adversely all stages of crop establishment. Lal (1985) found the evidence of soil compaction to be more severe at the plot borders, that is, the tractor's turning point and judging from the physical characteristics of soil in such areas, he concluded that continuous mechanized cultivation would substantially decrease the infiltration rate and hence crop growth.

Similarly, Braide (1991) found that the machine wheel traffic has an adverse effect on soil by causing its compaction. As soil becomes consolidated, the mechanical strength of the soil is increased, the water holding capacity is lowered and the infiltration capacity is reduced. The soil compaction from wheel traffic was also found to influence adversely all stages of crop growth and consequently the crop yield. Agboola and Omuetti (1982) stated that another effect of mechanical cultivation is that the practice enhances the solubilization of soil particles and the resultant formation of clay-pans. The compaction leads to many consequences like waterlogging, temporary saturation, erosion and poor germination and seedling development. The effect of tillage on some physical and hydrological properties of soil is presented in Table 1. The results showed that the conventional tillage adversely affected porosity, moisture retention and saturation hydraulic conductivity.

Table 1: The effect of tillage and some Physical and Hydrological Properties of Soil.

Parameter	No-tillage	Convectional Tillage
Porosity (%)	48.1	38.6
Moisture retention (%)	30.0	19.0
Saturation hydraulic Conductivity (cm/day)	753	183.0

Source: Opara-Nadi and Lal (1986)

THE EFFECTS OF MECHANICAL CLEARING ON CHEMICAL AND BIOLOGICAL PROPERTIES OF SOILS

A significant change in the originality of soil properties also affects its chemical and biological status. Agboola (1985), reported that the mechanical land clearing and tillage have been found to affect soil PH, total Nitrogen, available P, exchangeable Ca, Mg, K, Na, some micronutrient like B, Ca, Na, Zn, and Fe. The situation can become aggravated in the face of continuous cropping. Soil nutrients losses can be quantified, and measured in terms of economic costs. F.A.O. (Food and Agricultural Organization) study estimated that for 38 countries of sub-saharan Africa in 1983, the average net removal of nutrients from the soil was 22kg, 6kqp and 18kg per year with rates expected to rise in future (Jasiorowski, 1990).

The use heavy machine for clearing causes deforestation and upset the biological species in the ecosystem. The macroflora and micro fauna are exposed to desiccation and destruction as a result of increased soil temperature and reduced moisture regimes. The rate of this destruction is lower under the traditional farming method for land preparation. The macro fauna are affected by soil

compaction and the burrowing of the earthworm is reduced because of low oxygen diffusion. Plots with high earthworm activity often produce better yields (Lal 1979).

EFFECT OF MECHANICAL CLEARING AND TILLAGE ON CROP YIELD

Tractorisation continuously reduces the rooting zone by the removal of top soil. Soil productivity declines as the erosion reduces both depth of the root zone and the soil moisture holding capacity. The effect of soil removal is presented in Table 2. The result showed gradual decrease in grain and stover yield of maize as the removal of the soil depth increases.

Table 2: Effect of Soil Removal (depth) on Maize Grain Yield and Stover Yield from an Alfisol near Ibadan, Nigeria

Soil Removal depth (cm)	Grain Yield t/ha	Stover Yield t/ha
0	2.0	4.2
10	0.7	2.6
20	9.2	1.9
LSD	0.6	0.6

Sources: Lal (1983)

Land bulldozing has depleted soil organic matter content. This phenomenon reduces crop growth and yields through their effects on soil structure, porosity and availability of soil water and plant nutrients. It should be noted that crop response to applied fertilizer also depends on soil organic matter (Agboola and Omuetti, 1982).

EFFECTS OF CULTIVATION METHOD ON CROP YIELD

Mechanical clearing and tillage operations have been found to affect the yield of crops adversely. The effects of clearing and tillage method on crop yield is shown in Table 3. On the average, mechanical tillage was found to adversely affect crop yields.

Table 3: Effects of Tillage on Crop Yield (kg/ha)

Crop	No Tillage	Hand Tillage	Mechanical Tillage
Maize	1060	1510	1270
Cowpea	1029	475	389
Sorghum	2800	-	1660

Source: Hulugalle et al (1991).

Maize yield reduction was also reported by Braide (1991) to be caused by Vehicular passes. This could be due to soil compaction. The maize yield was found to decrease with increase in vehicular passes (Table 4).

Table 4: Effect of Vehicular passes on Maize Yield (kg/ha)

No. of Passes	Maize Yield kg/ha
0	5120.64
2	4869.13
8	3527.90
14	3705.67
LSD 0.05	345.30

Source: Braide (1991).

CONCLUSION AND RECOMMENDATIONS

Land clearing and tillage methods should aim at conservation of organic matter, soil moisture, soil resources, improve root system development and prevent rapid soil degradation and therefore it should be soil specific. In the tropics, large scale mechanized land development have resulted in rapid soil degradation with consequent crop failure. On the other hand, the traditional clearing method is time wasting and the labour is increasingly scarce but it enhances agriculture sustainability so that our future generations can benefit from inheriting our soils.

RECOMMENDATIONS

1. Light tractorized machines should be developed for use in the tropics and the tractor operators should be trained on the management of tropical soils. This approach will make farming attractive since it would be unusual in our modern society to see the majority of the present Nigerian farmers still using the same ancient tools in their original shapes and forms.
2. The farmers in the far north of Nigeria should intensively use animal traction technology because it is suitable in their environment.
3. Clean clearing should be avoided in the tropics while Agroforestry and alley cropping should be encouraged.

QUESTIONS

- 1(a) What is sustainable agriculture?
(b) Discuss how the use of heavy tractor for farm clearing and tillage cannot lead to sustainable agriculture in the tropics.
- 2(a) State the characteristics of Nigeria soils.
(b) Draw and label ten African farm tools and Explain why the named tools are not faced out completely in Nigeria agriculture.

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