Establishment of pineapple orchards and soil loss control systems for erodible tropical ultisols of Southeastern Nigeria.

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ESTABLISHMENT OF PINEAPPLE ORCHARDS AND SOIL LOSS CONTROL SYSTEMS FOR ERODIBLE TROPICAL ULTISOLS OF SOUTHEASTERN NIGERIA.

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ABSTRACT - Pineapples (*Ananas comosus* variety Smooth Cayenne) were established on ploughed farms in April (early rain), June (mid rain) and August (late rain), and mulched with 5 cm compacted depth of ricehusk, sawdust and woodchip respectively. The experiment was laid on a 9% slope of erodible tropical ultisol in the rainforest belt of Southeastern Nigeria to assess the soil loss, chemical and physical changes, and weed growth during the establishment phase preceding canopy cover and the ultimate effect on the pineapple fruit yields.
Pineapples established in April and June matured early but the fruit yield decreased particularly in unmulched pineapples. Soil loss and heavy weed infestation were the major agronomic problems when pineapples were planted, but unmulched or mulched with ricehusk, in April or June. Although pineapples planted in August matured late, the fruit yield increased significantly (P. 0.05) when mulched with woodchip which proved the most effective mulch for soil conservation, weed suppression and enhanced pineapple fruit yields for any time of planting of pineapples.

PLANTATIONS D'ANANAS ET SYSTEMES DE LUTTE CONTRE L'EROSION DANS LES ULTISOLS TROPICAUX FRAGILES DU SUD-EST DU NIGERIA.

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RESUME - Des ananas Cayenne lisse, plantés sur sol travaillé, en avril, juin et août soit, respectivement, en début, au milieu et à la fin de la saison des pluies, ont bénéficié d'un mulch de 5 cm d'épaisseur constitué, selon les cas, de balle de riz, de sciure ou de copeaux de bois. Pente du terrain de 9 p. 100 sur un sol érodable de la ceinture forestière, humide, du Sud-Est du Nigéria. Evaluation de la perte de sol, des changements physico-chimiques, de la croissance des adventices au cours de l'étape précédant celle de la couverture du sol par l'ensemble des feuilles et enfin, étude de l'effet sur les récoltes. Les plantations d'avril et de juin ont produit plus rapidement mais le rendement a diminué surtout sur les parcelles sans couverture (mulch). Perte de sol et forte poussée de mauvaises herbes ont été les problèmes majeurs pour les plantations d'avril et de juin sauf pour celles à terrains nus ou recouverts de balles de riz. En dépit d'une récolte plus tardive, les parcelles d'août ont connu une augmentation de rendement significative dans le cas du mulch à base de copeaux ; ce type de couverture, quelle que soit l'époque de plantation s'est révélé le plus efficace pour la conservation du sol et la suppression des adventices.

INTRODUCTION

Pineapple (*Ananas comosus* variety Smooth Cayenne) is produced in the rainforest zone of Nigeria (Keay, 1963) between latitudes 5° and 8° North of the equator. This agroecological zone favours the production of numerous food and cash crops in a characteristic complex farming enterprise (Okigbo, 1978) where the allocation of limited resources particularly land and labour depends largely on the satisfaction of the domestic, cultural and socio-economic needs of the farm family. Thus, and until recently too, pineapples were grown in scattered rural farms as intercrops with cash and food crops, in taungya (*) agroforestry system, homestead and as boundary crops in highly fragmented family farms (Ucheagwu, 1988). This production system only satisfied local consumption as a minor table dessert after highly demanded bananas, oranges, pawpaw and mango.

However, increased national interest in commercial pineapple production followed the economic awareness as a foreign exchange earner and important source of raw material in pineapple - based fruit processing industry and a viable alternative to the predominant orange-based agroindustries. The net effect was the extensive establishment

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* - Taungya : a reafforestation system whereby the interrows are cropped with food crops prior to canopy cover. Pineapple and plantain feature prominently in taungya systems of Nigeria.

and rapid expansion of hectarage under pineapple production in limited rainforest region. Consequently, some arable farms and forest lands including undulating lands and hill sides were cleared and cultivated to pineapples. The usual total vegetation clearance and land preparation practices of ploughing and harrowing for pineapple production aggravated soil erosion through accelerated surface run off and reduced water infiltration. Thus, soil erosion which occurs during the early pineapple establishment, constituted a major hindrance to intensive pineapple production in most parts of the rainforest belt following top soil losses and gulley development.

Pineapples are propagated vegetatively using suckers which establish slowly in the field. The hardy nature of the sucker coupled with its inherent rooting ability and establishment apparently nullified the deleterious effect of time of planting, deteriorating soil characteristics erosion and poor fruit yield since these were scarcely monitored. Although the initial plant population per hectare (45,000 plants/ha) and leaf area index are high at planting, further canopy development thereafter for effective soil cover is gradual (Obiefuna, Ucheagwu and Majumder, 1987) because of the low rate of leaf proliferation and growth. Thus the period preceding effective vegetative ground cover in pineapple orchards exceeds six months (Obiefuna *et al.*, 1986) most of which may occur within the rainy season (Archbold and Hamilton, 1945) depending on the time of planting. Exposure of ultisols to intensive rainfall reportedly (Maduakor, 1988 ; Asiabaka, 1988 ; Ofomata, 1955) resulted in severe nutrient and soil loss resulting in gulley erosion in most parts of southeastern Nigeria. In tropical arable farming, organic mulches are the panacea to soil loss prior to canopy cover (Okigbo and Lal, 1980).

In major pineapple producing countries, example Hawaii, black plastic mulch is used extensively to check soil erosion, weed growth and leaching of nutrients etc. prior to adequate canopy development. However, such a practice could aggravate nematodes and high soil temperatures. Plastic mulch, like other petroleum products, is too expensive to justify the additional costs. Although the use of organic mulch in plantains grown in same ecological zone, suppressed weed growth and increased fruit yield, (Obiefuna, 1986), the study did not monitor the effectiveness on soil erosion control particularly when grown on slopes or at different times of the rainy season. However, the use of different but equally effective organic mulches could ameliorate the usual problem of mulch insufficiency associated with organic mulch (Obiefuna, 1986).

Alternatively, minimum soil exposure may be achieved through adjusted time of planting since early, mid-and late rains vary in intensity, frequency and soil erosivity. Although the effect of time of planting on growth and yield of pineapples in Nigeria has not been reported, available information on plantains (Obiefuna, 1986 ; Ndubizu and Okafor, 1976) and other tropical crops (Njoku, 1959) in the same agro-ecological zone revealed significant yield increases through proper time of seeding. A sustainable pineapple production system is therefore required to check soil erosion during the establishment phase and guarantee heavy pineapple yields. This paper reported the adequate time of planting and mulching to check soil erosion and enhance pineapple production in the tropical rainforest belt of Southeastern Nigeria.

MATERIALS AND METHOD

The experiment was conducted at Owerri latitude 5°27'N and longitude 7°02'E on the university agricultural farm within the tropical rainforest belt. The climate (Table 1) is characterised by heavy rainfall (1000 - 2000 mm annually), spread from April to October, with peak rainfall between May and September. The months of November to March are usually dry with low relative humidity (51-71%). The temperature is fairly uniform with diurnal range of 2-3°C. The soil is a well drained sandy loam ultisol on a 9% slope. Prior to experimental layout, composite soil samples at 0.-30 cm depth were collected using a 5 cm diameter soil augur, and analysed for some physical and chemical properties. At the end of the experiment too, similar soil samples were collected from each mulch treatment and analysed. The treatments were April (early rain), June (mid rain) and August (late rain) pineapple planting which were unmulched (control) or mulched to 5 cm compacted depth with ricehusk, sawdust and woodchips respectively at each time of planting. The experiment was laid out in randomized block design and replicated four times.

During each time of planting, experimental farm was disc ploughed and harrowed once to a 25-30 cm depth. The Smooth Cayenne pineapple crowns, 450 g each, were collected from the University pineapple orchard, soaked in 0.1% benlate paste to control fungal rots. The suckers planted in a two row system of 0.5 x 0.3 m with one metre interrow. Thirty five dressed crowns were planted within each treatment plot which measured 3.0 x 2.0 m across the slope and adequately provided with run off collection trenches. The planting of pineapple suckers and mulching were each completed within the first week of April, June and August. Also at each land preparation, a blanket application of 200 kg/ha of compound fertilizer N.P.K. 15-15-15 was incorporated into soil. At 50% flowering, random root core samples were taken with 5 cm augur and root dry weight determined. The pineapple fruits were harvested half ripe.

Soil loss was assessed in each plot using the graduated spike technique (Schumm., 1956). Painted iron rods (8 cm long and 5 cm in diameter) were driven in to flush with the surface of the mulch materials or the ground as in the control. Twenty spikes were placed in-between rows of pineapples across the slope in each plot to enclose the sample pineapples. At the end of each heavy or group of small rains, the height of each spike above or below the surface of mulch material or soil was measured with a ruler. After each measurement, the spikes were again adjusted to flush with the soil or mulch surface. Exposure or burial of the spikes in a plot was summed up and soil loss calculated thus

$$\text{Soil loss} = \frac{\text{Total exposure (mm)}}{\text{Number of nails}} \times 6\text{m}^2 \times D_b \frac{\text{kg}}{\text{m}^2} \times \frac{\text{m}}{10^3\text{mm}}$$

where D_b = bulk density.

Bulk density was measured after Black *et al.*, 1965. At 3 monthly intervals quadrat weed samples in each plot were collected, oven dried at 60°C for 48 hours to obtain weed dry weight. Pineapple leaf area was calculated using the linear relationship of leaf length and width (Bakakrishman *et al.*, 1979).

TABLE 1 - The weather records at Owerri during the period of the experiment.

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1987												
Rain fall (mm)	0.0	7.6	63.6	130.9	187.0	530.2	193.7	274.9	270.5	137.5	33.5	18.1
Relative humidity (%)	59	77	75	78	86	85	88	86	79	78	72	62
Temperature (°C)	26.5	28.7	28.5	28.2	26.8	25.4	25.7	25.6	25.3	26.3	26.4	26.0
1988												
Rain fall (mm)	0.0	6.0	249.4	149.2	195.2	220.7	301.7	383.4	340.0	201.7	58.3	21.4
Relative humidity (%)	66	54	66	73	75	78	83	81	80	73	74	51
Temperature (°C)	26.4	27.9	28.5	27.7	26.7	26.0	24.7	25.3	25.4	26.3	27.1	25.7
1989												
Rain fall (mm)	0.0	8.7	78.1	101.0	205.2	180.1	183.4	201.7	301.8	146.7	28.1	0.0
Relative humidity (%)	58	61	64	68	76	80	81	81	79	75	76	55
Temperature (°C)	26.9	28.4	27.7	26.8	26.9	27.7	25.3	24.5	25.5	25.7	26.9	24.9

RESULTS

Soil properties.

During the production cycle of pineapples, some physical and chemical properties remarkably changed within the 20 cm depth for the different mulch treatments (Table 2). Mulching significantly (P = 0.05) reduced bulk density and the percentage sand but increased those of clay, silt, and moisture retention capacity and nitrogen relative to the control. However, the soil acidity increased slightly under ricehusk and the control. The cation exchange capacity (CEC) increased in all plots at the end of the experiment.

Pineapple leaf area.

For the first 6 months after planting, the leaf area in pineapple was not significantly (P = 0.05) affected by either the mulch or the time of planting (Table 3). However, leaf area significantly increased by the 9th month particularly in mulched pineapples. Ricehusk and woodchip further enhanced leaf area development in early and late rain plantings. Thereafter, leaf area rapidly increased and then decreased in each treatment about the 12th month after planting. Since pineapples are monopodial, the cessation of further leaf area increases marked the transition to floral initiation growth phase.

Weed growth.

The time of planting and mulching significantly affected weed growth and development. Although weed growth was particularly heavy in each treatment within three months after planting, pineapples planted mid rain (June) were most affected followed by bare plantings in early (April) and late (August) rain plantings. Least weed development at the initial establishment occurred in late season planting. At each time of planting wood chip controlled weed growth most effectively while ricehusk though less effective, was definitely better than the unmulched in weed control. Each treatment revealed two different peaks of weed intensities at 3, and, 9 months in August planting, or 12 months for April and June plantings.

TABLE 2 - Some soil physical and chemical properties at 0.-20 cm depth at planting and end of experiment.

Parameter	At planting	At the end of experiment				
		Control	Ricehusk	Sawdust	Woodchip	LSD at 5%
Sand (%)	68.4	70.3	56.5	64.2	66.9	1.02
Silt (%)	18.1	18.0	18.4	19.2	18.8	0.06
Clay (%)	13.5	10.8	16.1	16.6	14.3	1.00
Bulk density ($Mg\ m^{-3}$)	1.25	1.32	1.29	1.27	1.22	0.04
Moisture control (%)						
Field capacity (0.3 bar)	16.1	15.8	17.5	17.8	18.3	0.40
Wilting point (15 bar)	6.5	6.3	8.4	8.7	8.8	0.6
pH ($CaCl_2$)	5.6	5.5	5.3	6.0	5.8	1.2
Organic carbon (%)	1.83	1.71	1.98	1.92	1.89	0.05
NO_3-N ($mg\ l^{-1}$)	22.7	23.3	25.2	24.8	24.5	1.12
Available P ($mg\ l^{-1}$)	16.8	16.2	17.9	17.1	16.8	0.81
CEC (me/100 g)	11.0	11.1	12.2	11.6	12.3	0.34

TABLE 3 - The effect of time of planting and application of different mulches on pineapple leaf area and weed growth at various growth phases, after planting.

Time of planting	Mulch	Leaf area (X 10^3 cm^2)				Weed dry weight (t ha^{-1})			
		Months after planting							
		3	6	9	12	3	6	9	12
April	Unmulched	0.5	1.5	2.5	8.6	6.0	2.1	0.6	1.2
	Ricehusk	0.7	2.3	3.4	11.5	4.0	2.6	1.0	0.7
	Sawdust	0.8	2.8	3.7	12.4	5.3	1.4	0.6	0.6
	Woodchip	0.8	2.2	3.5	12.1	3.5	1.2	0.7	0.5
June	Unmulched	0.6	1.4	1.5	8.5	9.1	1.7	0.4	2.1
	Ricehusk	0.6	1.5	3.5	12.0	8.3	1.6	0.5	1.2
	Sawdust	0.4	1.2	2.3	10.7	6.9	1.3	0.7	0.8
	Woodchip	0.8	1.7	3.0	11.4	4.7	1.2	0.6	0.6
August	Unmulched	0.7	1.4	3.1	8.5	5.0	0.9	4.1	2.0
	Ricehusk	0.5	2.6	6.4	11.3	2.8	0.7	2.0	1.1
	Sawdust	0.5	2.1	4.2	9.3	2.0	0.4	1.6	0.8
	Woodchip	0.4	1.6	7.5	10.4	1.7	0.6	1.2	0.5
LSD at 5%		1.0	1.4	1.2	1.6	1.8	0.6	0.7	2.1

Soil loss.

The time of planting pineapples aggravated heavy soil loss in unmulched fields while mulching conserved the soil (Table 4). Soil loss was most severe when the pineapples were established in mid rains even under mulch. The severity of such losses accentuated with intensity and or duration of rainfall after planting particularly within the first six months of establishment. In early season planting, significant soil loss continued till the 9th month in the unmulched plots or those mulched with ricehusk. Mulching with sawdust or woodchip reduced both the quantity and duration of soil loss at each time of planting. Late season planting and mulching significantly reduced soil loss even within three months of pineapple planting.

Percentage canopy cover.

Canopy cover was very slow during the first 6 months of pineapple establishment without mulch (Table 4) irrespective of the time of planting. In mulched plots however, the canopy cover significantly improved but only woodchip mulch effected over 50% canopy cover during the early season planting. In the mid and late season plantings, canopy development dragged for over six months. Although mulching significantly improved canopy cover, only a small proportion of the potential canopy was developed. In effect only pineapples mulched with sawdust or woodchip attained full canopy cover within 12 months of planting.

TABLE 4 - The effect of time of planting and mulching on soil loss and percentage canopy cover over time.

Time of planting	Mulch	Soil loss (t ha^{-1})				Percentage canopy cover			
		Months after planting							
		3	6	9	12	3	6	9	12
April	Unmulched	2.88	1.87	0.37	0.31	6.6	28.7	69.6	86.0
	Ricehusk	2.10	1.80	0.34	0.21	6.0	34.5	78.4	91.5
	Sawdust	1.45	0.96	0.21	0.19	15.0	46.4	89.5	100.0
	Woodchip	1.14	0.64	0.13	0.05	16.8	54.0	100.0	100.0
June	Unmulched	3.20	2.01	1.17	0.34	6.4	20.2	36.7	78.4
	Ricehusk	2.34	1.33	0.85	0.21	8.8	22.6	45.6	86.6
	Sawdust	1.64	0.86	0.33	0.18	15.8	38.0	78.4	100.0
	Woodchip	1.42	0.64	0.21	0.04	16.4	49.8	89.5	100.0
August	Unmulched	2.82	1.17	1.10	0.32	6.2	18.6	30.2	79.5
	Ricehusk	1.27	0.74	0.36	0.23	6.5	23.4	43.6	88.4
	Sawdust	1.01	0.47	0.26	0.14	16.8	36.8	86.5	100.0
	Woodchip	0.92	0.24	0.06	0.04	18.9	44.4	96.3	100.0
LSD at 5%		0.54	0.14	0.12	0.09	6.01	9.24	8.61	7.45

TABLE 5 - Rooting, flowering and fruit yield of pineapples planted and mulched at different times.

Time of planting	Mulch	Root dry weight (g)	Days of 50% flowering	Days of 50% harvest	Plant crop fruit yield (t ha^{-1})	First ratoon fruit yield (t ha^{-1})	Total soluble solids (%)	Sucker per plant at fruit harvest	Total fruit yield (t ha^{-1})
April	Unmulched	3.4	367.5	478.3	63.7	43.6	14.6	0.0	107.3
	Ricehusk	6.4	329.3	406.8	90.3	61.8	16.3	0.0	152.3
	Sawdust	6.6	328.0	427.4	90.0	68.4	17.8	2.8	158.4
	Woodchip	7.6	320.1	417.4	98.3	78.0	18.4	1.8	176.3
June	Unmulched	1.5	354.3	411.2	63.5	36.3	13.2	0.0	99.8
	Ricehusk	5.4	333.2	454.6	76.3	41.5	13.4	0.0	118.0
	Sawdust	6.2	342.2	486.0	90.0	74.6	16.4	2.8	164.6
	Woodchip	6.6	325.4	445.6	91.8	76.9	16.8	1.2	168.7
August	Unmulched	2.6	387.2	515.0	62.7	41.2	16.8	0.0	103.9
	Ricehusk	5.4	329.0	452.4	94.3	78.6	18.4	0.4	172.9
	Sawdust	6.8	331.6	469.6	95.3	77.4	18.8	3.2	172.7
	Woodchip	7.2	345.4	489.8	104.4	89.7	18.8	1.6	194.1
LSD at 5%		1.02	29.68	26.08	5.84	9.62	1.09	1.52	9.04

Root development.

Root development in pineapples within 20 cm depth was significantly enhanced by the time of planting, mulching and mulch source (Table 5). The unmulched pineapple established during the early rains developed massive roots while phase established midrains without mulching developed poor roots. Pineapples mulched with woodchip and sawdust consistently produced better root system than those mulched with ricehusk irrespective of the time of planting.

Plant crop yield.

The unmulched pineapples established in early and mid rains flowered after a similar vegetative growth periods (Table 5). However, unmulched pineapples established with late rains flowered significantly late. Fruit maturity and harvest followed a similar pattern. Although mulching enhanced flowering and fruit harvest in pineapples, the individual effects of the different mulches manifested between but not within the time of planting. Thus the fruits of pineapples established in early rains and mulched with either woodchip or sawdust were harvested significantly earlier than those planted and similarly mulched in mid and late rains. Mulching rather than the time of planting increased fruit yield in pineapples. In early and late season plantings, pineapples mulched with woodchip produced significantly heavier fruits than those of other mulches and least fruit yielding unmulched control. In the mid season planting, pineapples mulched with woodchip or sawdust produced similar quantities of fruits significantly heavier than those produced under ricehusk mulch.

Ratoon crop yield.

The fruit yields of first ratoon pineapples in all treatments were remarkably lower than those of plant crop in the unmulched plots. Fruit yield decreased least in mulched pineapples for each time of planting. However optimal fruit yields were obtained when pineapples were planted late and mulched with woodchip, sawdust or ricehusk respectively. Alternatively pineapples could be planted in early season and mulched with woodchip for enhanced fruit yields.

Total soluble solids.

The taste (quality) of the pineapple fruits was significantly influenced by the season of planting, mulching and mulch types (Table 5). Thus the percentage total soluble solids was least in pineapples planted during mid rains without mulching or mulched with ricehusk. The unmulched pineapples planted with late rains produced tastier fruits than those established with the early rains. For each time of planting mulching with either sawdust or woodchip significantly improved the fruit quality.

Number of suckers.

Mulching and mulch type rather than the time of planting enhanced sucker development in pineapples. Sawdust generated the largest number of pineapple suckers in each time of planting particularly when pineapples were established in the late rains. At the time of fruit harvest, sucker formation was generally poor in unmulched pineapples or those mulched with ricehusk.

Total fruit yield.

Although the total fruit (plant and ratoon) yield in unmulched pineapples was not significantly affected by the time of planting, mulching enhanced the aggregate fruit yields within and between seasons of planting. Maximum total fruit yield was harvested when pineapples were established in the late rains and mulched with woodchip. However, pineapples planted and mulched with woodchip in the early rains and those planted in the late rains and mulched with sawdust or ricehusk produced comparatively higher total fruit yields than any other treatment. Within each time of planting, pineapples mulched with woodchip produced the heaviest total fruit weight per hectare, and closely followed by those mulched with sawdust and ricehusk.

DISCUSSION

Pineapples were established vegetatively with crowns characterised by numerous open leaflet rosette. Although the initial pineapple population at planting was high ($45{,}000 \times ha^{-1}$), the period for total canopy cover dragged for over 6 months irrespective of the time of planting (Table 4) because of the slow rate of crop establishment and leaf development even under increased nitrogen fertilization (Obiefuna *et al.*, 1986). Therefore, during the establishment growth phase, the highly erodible ultisol was exposed to different heavy rainfall durations and intensities (Table 1) for each time of planting. Pineapples established in April (early rains), had over six months of adequate rainfall which accelerated the vegetative (Table 3) and reproductive growth phases in pineapples resulting in early maturity and fruit harvest (Table 5). For these pineapples planted in April, the rainfall days were few and intensity low and the progression gradual (Table 1). The unsaturated soil condition after the preceding dry season accelerated infiltration and so reduced run off and soil loss (Maduakor, 1988). Under these conditions, the mulches effectively compacted and pineapples rapidly established over 30% vegetative prior to the June-July heavy rainfall.

However, during the June mid rain planting, the rainfall had peaked, the soil saturated and the water infiltration drastically impeded (Boers *et al.*, 1988). Thus under unmulched conditions, the prevalent heavy rainfall culminated in excessive run off and soil loss (Table 4). The observed high soil loss during this mid rain planting even in mulched plots resulted from pulverised and unconsolidated soil and mulches (Obi, 1982).

In the late rain planting, however, the soil exposure to rains was least following the onset of dry season in November, barely 3 months after planting. The incidence of drought delayed canopy development but at the same time, minimised run off and soil loss particularly under mulch which conserved moisture and temperature (Lal, 1981). Water consumption in pineapple fields is primarily due to losses from the surface soil (Ekern, 1965). The situation was effectively checked by mulching with woodchip and sawdust until effective canopy cover was accomplished (Table 4) prior to the peak of the later erosive rains. The reduced soil loss in established pineapple orchard, even in unmulched plots may be associated with the rosette leaf arrangement, dense root mat and high leaf area index. These constitute effective soil surface cover which dissipated the erosive energy of the raindrops (Boers *et al.*, 1988). The effectiveness was further enhanced by mulching during the establishment phase in pineapples. Woodchip and sawdust effected the much needed pre-establishment cover which minimised soil water loss and pineapple thermal period (Ekern, 1965).

Growth and development in pineapple is monopodial and so both the vegetative and reproductive growth phases develop from one axis after a transition interphase. The response of pineapple to drought or any other adverse stimulus depends to a large extent on the pineapple growth phase. Thus pineapples established during the late rains compensated the initial 3 months drought through prolonged vegetative growth and improved fruit yields. Late rain pineapple establishment and mulching are advocated because of improved soil conservation, reduced weeding rounds and increased pineapple yields.

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PLANTACIONES DE PINA Y SISTEMAS DE LUCHA CONTRA LA EROSION EN LOS ULTISOLES TROPICALES FRAGILES DEL SUR-ESTE DE NIGERIA.

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RESUMEN - Piñas de Cayenne lisse, plantadas sobre suelo trabajado, en abril, junio y agosto, o sea al inicio, mitad y final de la estación de lluvias, fueron beneficiadas con un mulch de 5 cm de espesor constituido, según el caso, de cascabillo de arroz, de aserrín o viruta de madera. Pendiente del terreno 9 p. 100 sobre un suelo erosionable del cinturón forestal, húmedo, del Sur-Este de Nigeria. Evolución de la pérdida de suelo, cambios físico-químicos, crecimiento de adventicias durante la etapa que precede a la de cobertura del suelo por el conjunto de hojas y finalmente, estudio del efecto sobre las cosechas. Las siembras de abril y junio produjeron más rapidamente, pero el rendimiento a disminuido sobre todo sobre las parcelas sin cobertura (mulch). Pérdida de suelo y fuerte crecimiento de malezas fueron los mayores problemas para las siembras de abril y junio, excepto por las de terrenos desnudos o recubiertos con cascabillo de arroz. A pesar de una cosecha más tardía, las parcelas de agosto tuvieron un aumento de rendimiento, significativas en el caso sel mulch a base de viruta ; este tipo cobertura, sin importar la época de siembra, se reveló más eficaz para la conservación del suelo y la supresión de las adventicias.