Evaluation of Different Tillage Practices for Monocultural Cowpea (*Vigna unguiculata* (L.) Walp) Production in Ibadan, South Western Nigeria

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Keywords: Cowpea – Production – Soil Properties – Economics Returns.

Summary

*A two-season (rainy and dry) study was conducted in 1993 at the Teaching and Research Farm, University of Ibadan, Nigeria to assess the most productive tillage practice for monocultural cowpea (*Vigna unguiculata *(L.) Walp) production. Completely randomised block design with four replications was used and tillage treatments were: No till-Slash and Burn (NSB), No till-Herbicide applied (NH), Conventional-ploughed and harrowed (CT), and Minimum-ploughed only (MT).*

Results revealed that tillage practices had no significant effect on percentage emergence, leaf and branch number in both seasons. In the first season, plant height was significantly ($P < 0.05$) influenced by tillage treatments at 2 and 4 weeks after sowing (WAS) with NH showing superiority over the other treatments. In the second season, plant height was significantly ($P < 0.05$) higher in NSB and MT treatments at 6 and 8 WAS, respectively. Pod and grain yield (t ha^{-1}) were not affected by tillage treatments in the first season but in the second season, NSB (1.84 t ha^{-1}) and MT (1.53 t ha^{-1}) showed significant superiority over other treatments. The highest cost of production was observed under NSB while CT produced the highest economic returns. Some soil properties were also influenced with NSB treatment having a higher soil bulk density at sowing and 6 WAS than the other treatments, while NH recorded a higher soil moisture content at 6 WAS than the other treatments. The study also suggests that with optimum precipitation, CT appears a better land preparation option for cowpea production.

Résumé

*Une étude a été menée en 1993 à la ferme d'enseignement et de recherches de l'université d'Ibadan, Nigeria, pour déterminer la forme de travail du sol la plus productive pour la production de niébé (*Vigna Unguiculata *(L.) Walp) en culture pure. Un dispositif de blocs complètement randomisés avec quatre répétitions, a été utilisé et les traitements de travaux de sol étaient : pas de travail manuel du sol – semis direct après défrichement et brûlis (NSB), pas de travail du sol – application d'herbicide (NH), labour conventionnel profond (CT), et labour léger (MT).*

Les résultats ont révélé que, les travaux du sol n'avaient pas d'effets significatifs sur le pourcentage de levée et sur le nombre de feuilles et de branches pendant les deux campagnes d'étude. Lors de la première campagne, la hauteur des plantes a été influencée de façon significative ($p < 0.05$) par le mode de travail du sol : 4 semaines après semis les plantes cultivées avec le traitement NH étaient plus grandes que celles produites avec les autres traitements. Une tendance similaire a été observée lors de la seconde campagne, le traitement NH induisant une croissance en hauteur des plantes significativement ($p < 0.05$) plus élevée que celles des traitements NSB et MT respectivement 6 et 8 semaines après le semis. Le rendement en gousses et en graines (t ha^{-1}) n'a pas été significativement affecté par le mode de travail du sol lors de la première campagne alors qu'une différence significative a été observée pour les traitements NSB (1,84 t ha^{-1}) et MT (1,53 t ha^{-1}) lors de la deuxième campagne.

Le traitement NSB est le plus coûteux tandis que le traitement CT produit le plus grand bénéfice économique. Quelques propriétés du sol ont également été influencées par le traitement NSB qui présentait une plus grande densité de volume au semis et 6 semaines après le semis que les autres traitements tandis que NH enregistrait une plus grande humidité du sol 6 semaines après le semis que les autres traitements. L'étude suggère aussi qu'avec une précipitation (pluviométrie) optimale, CT apparaît être une meilleure option de travail du sol pour la production de niébé.

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Introduction

The challenge of food production in continuous cropping systems in the humid and sub-humid tropics of Nigeria is to manage fragile soils to ensure sustained productivity, without reverting to bush fallow or shifting cultivation practices of traditional agriculture. Tackling this problem becomes more pertinent as good arable land continues to diminish in the region. Ideal crop production systems in the tropics need to be developed in such a way that combination of good land, crop and pest management practices can be assured thereby guaranteeing the farmers moderate to high crop yields on a sustainable basis.

Appropriate soil tillage is considered necessary for enhanced crop production since it creates a greater soil volume for seed germination and emergence, seedling establishment and root growth (14, 22). Despite the continuous increase in the nation's population, urbanization and industrialization which call for proper soil management, the perceived positive attributes of tillage operations is yet to be fully tapped in this region of the world. Some researchers (1, 8, 32, 35) have questioned the rationale of this practice since traffic damages soil properties, and lowers crop performance. However, Akobundu and Deutsch (3) observed that in some soil types, some level of tillage is imperative to produce good soil tilth required for root development.

Generally however, research findings as to the superiority of crops grown on tilled plots to those on non-till plots have been conflicting and contradictory. Some investigators (9, 10, 11, 24, 26, 27) reported either no significant differences between tilled and zero-tilled plots or significant superiority of no-till over tilled plot. Other workers (16, 17, 29) found significant superiority of tilled plots over no-till plots particularly where there was prolonged soil moisture stress.

Results of studies on economic returns of various tillage systems are equally contradictory. Henderson and Stonehouse (15) and Stonehouse (34) observed that the empirical evidence on comparative short term economics is contradictory and confusing. In a minority of cases, conventional tillage systems appear to be economically superior especially in cooler temperate zones and where topsoils are deeper and/or less steeply sloping because of greater topsoil volume, reduced soil loss and high organic matter content. This findings however contrasts with the conclusion of Philips and Young, (32) that no tillage significantly reduced certain production costs because of elimination of seed bed preparation. Therefore, the objectives of this study were: (a) To assess the necessity or otherwise of tillage systems for cowpea growth and yield; (b) evaluate changes in soil properties, and (c) examine the costs of production and economic returns under various tillage systems for monocultural cowpea production in Ibadan, Nigeria.

Material and methods

The experiments were conducted during the 1993 planting seasons at the University of Ibadan Research Farm at Ajibode, Ibadan (Latitude 07°30'N, Longitude 3°45'E with an altitude of 220 m above sea level). This forest zone has a bimodal pattern of rainfall, with a first rainy season commencing from April to July, a dry spell in August followed by a second rainy season, September to November. Table 7 gives detailed climatic information of the study area. The soil is well drained sandy soil of Egbeda series (33) and of the broad group of tropical Alfisols (13).

Experimental Design

There were four treatments, randomised in each of four blocks. Block size was 65x10 m with interblock spacing of 4 m and a plot size of 15 x 10 m with inter plot space of 3 m. Tillage treatments consisted of:

(a) no tillage, slashed manually, followed by *in situ* burning of the debris after drying;

(b) no tillage, vegetation cover sprayed with a herbicide (paraquat-1-1-dimethyl 4-4-dipyridium) at 16 ml to 1 l of water (5 kg a.i. ha^{-1});

(c) minimum tillage, ploughed (at about 15 cm soil depth) with tractor mounted disc plough once only; and,

(d) conventional tillage, ploughed and harrowed (at about 15 cm soil depth) once with tractor mounted disc plough and harrow. The vegetation cover of the plots was mainly weeds with very sparse stands of shrubs.

Cultural Details

In both the first and second growing seasons, plantings were done in May and September, respectively. The cowpea, cultivar IT86D-1010 (extra early maturing (60 days); determinate, erect and day insensitive), obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria was planted manually at a spacing of 60 cm (between rows) and 30 cm (within row). Two seeds were planted per hole at 3 cm depth giving 55,555 holes or 111,110 stands per hectare. Weeding was done manually from the third weed after sowing (WAS). Pest control was carried out with insecticide (cymbush 10EC (cypermethrin) at a biweekly interval during the pre-flowering stage at the rate of 2 ml to 1 l of water. Some of the pre-flowering stage pests include, *Ootheca mutabilis, Luperodes lineata* and *Zonocerus* spp. At reproductive stage, nuvacron 40 ScW was applied at the rate of 2.5 ml to 1 l of water using a knapsack sprayer. Some of the prevalent pests at reproductive stage, were; *Anaplocnemis curvipes, Riptortus dentipes, Acanthomia* spp. and *Nezara viridula.*

Measurements

Parameters measured were emergence percentage, plant height, number of leaves and branches, and pod and grain yields. Cost of production (planting materials, insecticides, harvesting and shelling), economic return and changes in soil properties were also assessed. Emergence count was taken 7 days after sowing by counting total number of emerged stands against total number of seeds planted and expressed in percentage.

Twenty plants per plot were tagged for determination of plant height, number of leaves and branches. Pod and grain yields were assessed by harvesting all pods and measuring grain weight after shelling using toploading balance (with a basin-like top and calibrated in kilogramme). Cost of production and economic returns were determined using benefit: cost analysis in order to determine the benefit that could accrue to cowpea production given the cost of production. A discount factor of 19% (current interest rate) as cited by FOS (12) was used to obtain discounted Benefit: cost ratio. Soil samples (0-15 cm) were collected before and after studies were conducted to determine changes in soil nutrient status. Fifteen core samples were collected and bulked per plot. These composite samples were later bulked on treatment basis and analysed for the following soil parameters: pH using method described by IITA (18), organic carbon using Walkley and Black (36) method and total nitrogen by the regular Macro-Kjeldahl method (20). Available phosphorus was determined by Bray No. 1 method (6) while flame photometry method was used to determine calcium, sodium and potassium. Magnesium, manganese, copper, zinc, base saturation and iron were determined by Atomic Absorption Spectrophotometry as described by Perkin-Elmer Corp. (31). Electrical conductivity was determined using conductance bridge (Wheatstone bridge arrangement). Organic matter was determined by multiplying the uncorrected value of organic carbon by a constant factor of 1.724 as cited by Odu et *al.*, (28) while cation exchange capacity was obtained by the summation of the total exchangeable acidity. and soil texture were determined using the method described by Jackson (19) and Bouyoucos (5), respectively. Soil bulk density and moisture content were determined using core method (4).

Results and Discussion

Emergence and Height

The results of emergence and height of cowpea as influenced by tillage methods are presented in Table 1. The Table revealed that in both first and second growing seasons, seedling emergence was not significantly affected by tillage treatment as excellent emergence (ranging from 90.6 to 91.6%) in the first season and (94.6 to 97.4%) in the second season was observed in all treatments.

Plant heigt was significantly influenced ($P<0.05$) by tillage treatments at 2 and 4 WAS in the first season with no tillage (using herbicide) treatment being significantly higher than the other three treatments. No significant difference was observed among treatments at 6 and 8 WAS. In the second season, no significant difference at 6 and 8 WAS. In the second season, no significant difference existed among treatments at 2 and 4 WAS. However, at 6 and 8 WAS no tillage (slash and burn) and minimum tillage showed significant superiority to the other two treatments. Coefficients of variation for the parameters indicate higher variations during the first season than the second season due to preponderance of soil moisture in the first season.

The excellent emergence observed among all tillage treatments could be attributed to the availability of adequate soil moisture at the time of planting. In the two seasons, optimum rain fell during the sowing period and hence supplied adequate moisture for seedling emergence. Huxley (16) had earlier observed that with adequate rainfall, seedling emergence was very similar on no till and tilled plots. Generally, differences in plant height during the two growing seasons are probably related to soil moisture differences. Kamara and Godfrey-Sam-Aggrey (21) had earlier made similar observations.

Leaf and Branch Number and Pod and Grain Yields

The number of leaves and branches (at 100% flowering) and pod and grain yields are presented in Table 2. In both first and second seasons, number of leaves and branches showed no significant difference among the tillage treatments. However, on average, conventional and minimum tillage were superior for the two parameters, while no till (slash and burn) and conventional tillage had the least number of leaves and branches during the first and second seasons, respectively. In the first season, pod and grain yields showed no significant difference. Significant differences ($p<0.05$) were observed in pod and grain yields in the second season. No till (slash and burn) and minimum

Table 1

Effects of Tillage Practices on the Emergence and Height of Cowpea.

Treatment	First season					Second season				
	Emergence %	WAS* 2	4 Height (cm)	6	8	Emergence %	WAS* 2	4 Height (cm)	6	8
No till (slash and burn)	91.6a	9.9b	15.4b	82.8a	108.5a	95.0a	10.6a	16.8a	98.1a	105.3b
No till (herbicide applied)	90.6a	13.3a	17.9a	86.2a	114.7a	94.6a	11.3a	16.5a	86.6b	95.9c
Conventional	91.4a	9.7b	15.1b	82.7a	127.1a	97.4a	10.0a	18.0a	88.0b	99.2b
Minimum	91.4a	9.4b	15.1b	93.2a	120.9a	95.2a	9.9a	18.0a	98.8b	108.6a
$S\bar{X}(\pm)$	1.9	1.0	0.8	14.7	9.9	1.1	0.7	0.4	0.6	0.7
CV (%)	2.9	13.0	6.8	24.1	23.8	1.5	13.1	4.4	1.2	3.7

*WAS = Weeks after sowing.

a, b, c, means in the same column bearing the same letter are not significantly different ($P<0.05$) according to Duncan's Multiple Range Test (DMRT).

Table 2
Effects of Tillage Practices on Cowpea Leaf and Branch Number and Pod and Grain Yield.

Treatment	First season				Second season			
	Leaf No. plant-1	Branch No. plant-1	Pod yield t ha-1	Grain yield t ha-1	Leaf No. plant-1	Branch No. plant-1	Pod yield t ha-1	Grain yield t ha-1
No till (slash and burn)	21.1a	2.4a	2.1a	1.7a	37.7a	2.5a	1.8a	1.4a
No till (Herbicide applied)	23.4a	2.9a	1.9a	1.6a	36.3a	2.5a	1.3c	0.9b
Conventional	24.9a	3.0a	2.0a	1.6a	36.2a	2.3a	1.6b	1.5a
Minimum	24.8a	2.7a	2.0a	1.7a	38.1a	2.5a	1.8a	1.5a
$S\bar{X}(\pm)$	3.1	0.4	0.2	0.1	0.7	0.1	0.2	0.1
CV (%)	18.5	17.8	12.7	7.8	3.7	4.0	6.0	13.1

a, b, c, means in the same column bearing the same letter are not significantly different (P<0.05) according to DMRT.

tillage treatments showed significantly higher pod yields than the other two treatments with no till (using herbicide) being the least. Grain yield indicated no significant difference among no till (slash and burn), minimum and conventional tillage treatments. However, these three treatments showed significant superiority to no till (herbicide applied) treatment.

The absence of significant differences in pod and grain yields, and number of leaves and branches among the treatments in the first season could be associated with the influence of optimum soil moisture in all the treatments. In the first season, rainfall was more stable and uniformed than the second season (Tables 6 and 7). The optimum moisture supply probably guaranteed optimum soil temperature that might have been needed for uniform growth. Minchin and Summerfield (25) had earlier made a similar observation. The dry spell that set in during the later part of vegetative and early reproductive phases might have been responsible for the significant differences observed in pod and grain yields.

Cost of Production and Economic Returns to Management

The cost of production and economic returns to management are presented in Table 3. In both first and second seasons, the highest cost of production was observed in conventional and minimum tillage plots for both seasons, respectively. No till (slash and burn) exceeded no till (herbicide applied), conventional and minimum tillage by 23.9%, 40.6% and 32.0% in the first season, and by 26.5%, 34.2% and 35.4% in the second season, respectively. In both seasons, conventional tillage gave the highest economic return while the least was observed in no till (slash and burn) and no till (herbicide applied) treatments, respectively. The highest benefit: cost ratio was observed under conventional tillage for both seasons, while the least was under No till-slash and burn and No till-herbicide treatments for the two seasons, respectively. A combination of the two seasons revealed superiority of conventional over others with a mean Benefit: Cost ratio of 2.43.

Table 3
Cost of Production and Economic Return to Management (₦*ha-1) for Four Tillage Practices for Monocultural Cowpea Production.

Farm Operation	First season				Second season			
	Tillage Practice				Tillage Practice			
	No till (herbicide applied)	No till (slash and burn)	Conventional	Minimum	No till (herbicide applied)	No till (slash and burn)	Conventional	Minimum
(A) Production cost[a] (₦ ha-1)								
(1) Land Preparation	1400	3333	450	300	1400	3333	450	300
(2) Weeding	2666	4000	1333	2666	1333	2666	1333	1333
(3) Other costs	6327	6327	6327	6327	6327	6363	6327	6327
Total Cost of Production (TC)	10,393	13,660	8,110	9,293	9,060	12,362	8,110	7,960
(B) Yield (t ha-1)	1.6	1.7	1.6	1.7	0.9	1.4	1.5	1.5
(C) Gross Revenue (GR)[b]	24000	26100	24600	25500	12900	21300	22950	22200
(D) Return to Management (GTR)	13,607	12,400	16,490	16,207	3,840	8,974	14,840	14,240
Benefit/cost ratio	2.31	1.91	3.03	2.74	1.42	1.72	1.83	1.79

* N/B US$1 = ₦30.
a, Other costs include cost of planting material, insecticides, harvesting and shelling which was ₦1041, 620, 1333, and 3333, respectively.
b, Yield x unit price of ₦15000 t-1.
N/B Assumption here are:
(1) The cost of inputs remained unchanged.
(2) The prices of inputs were the same in the study area.

The higher cost of production observed in no till (slash and burn) treatment relative to other treatments in both seasons could be due to the cost of a single operation (labour for land preparation) which accounted for 24.4% of the total cost. This implies that in areas with relatively cheap sources of labour or in seasons with less demand or competition, slash and burn could give a lower cost of production since it has highest mean yield. Generally, these results are in agreement with the study reported by Huxley (16) and Omidiji et al. (30) that labour cost is always higher on zero-cultivated plots than cultivated plots.

Soil Properties

(i) Soil Bulk Density, Soil Moisture Content and Soil Texture: Soil properties as influenced by tillage treatments are as shown in Tables 4 and 5. Tillage treatments are as shown in Tables 4 and 5. Tillage treatments significantly influenced soil bulk density at sowing and 6 WAS while significant difference in soil moisture content was observed only at 6 WAS. No significant effect was observed on the percentage sand, silt and clay content.

(ii) Soil pH, Electrical Conductivity, Exchangeable Acidity and Base Saturation: Tillage treatments showed no significant effect on soil pH value, electrical conductivity and base saturation (Table 5).

(iii) Organic Carbon, Organic Matter, Available Phosphorus and Total Nitrogen: No significant effect was observed on organic carbon, organic matter, available phosphorus and total nitrogen content (Table 5).

(iv) Exchangeable Ca, Mg, Na, K and Cation Exchange Capacity: Tillage treatments indicated no significant effects on exchangeable Ca, Mg, Na, K and cation exchange capacity.

(v) Extractable Micronutrients – Mn, Fe, Cu and Zn: Tillage treatments showed no significant effects on Mn, Fe, Cu and Zn content.

Table 4

Effects of tillage practice on soil bulk density and moisture content.

	At sowing		6 weeks after sowing		10 weeks after sowing (At maturity)	
Treatment	Bulk density (g/cm^{-3})	Moisture content (%)	Bulk density (g/cm^{-3})	Moisture content (%)	Bulk density (g/cm^{-3})	Moisture content (%)
No till (slash and burn	1.4a	12.3a	1.4a	21.2b	1.4a	20.9a
No till (herbicide applied)	1.4a	7.7a	1.4b	23.3a	1.4a	27.1a
Conventional	1.4b	4.4b	1.4b	17.1d	1.4a	26.7a
Minimum	1.4b	9.6a	1.4b	18.6c	1.4a	26.5a
SX (±)	0.0	2.6	0.0	0.5	0.0	0.6
CV (%)	1.0	42.6	1.0	3.7	1.0	2.9

a,b,c,d, means in the same column bearing the same superscript are not significantly different (P<0.05) according to DMRT.

Table 5

Effects of tillage on soil chemical properties.

Tillage Practice		Soil pH (H_2O)	Elec. Cond. (mmho/cm)	Ex. acidity (ml/100g)	Org. C	Org. Matter %	Total N	Av.P (mg/kg)	Ca	Mg	Na Cmol/kg	K	CEC	Mn	Fe mg/kg	Cu	Zn	Base Sat. %	Sand	Silt	Clay
No till (slash and burn)	Initial	6.8	$0.9x10^{-5}$	0.08	0.74	1.27	0.07	1.56	0.90	0.23	1.04	0.21	2.46	102.00	41.50	1.10	4.10	96.75	89.80	7.40	2.80
	Final	6.8	$0.6x10^{-5}$	0.16	0.68	1.17	0.06	1.28	0.90	0.20	0.74	0.16	2.20	72.10	26.10	0.90	5.20	92.73	89.80	7.40	2.80
	% change	0	33.0	50.0	8.0	7.9	14.3	17.9	0	13.0	25.0	23.8	10.6	29.30	37.10	18.20	26.8	4.2	0	0	0
No till (herbicide applied)	Initial	6.7	$0.7x10^{-5}$	0.16	0.80	1.34	0.07	2.74	0.85	0.13	0.96	0.17	2.27	55.70	19.60	1.20	3.90	92.95	91.80	7.40	0.80
	Final	6.8	$0.6x10^{-5}$	0.06	0.91	1.57	0.08	2.47	0.95	0.27	0.87	0.20	1.42	68.90	28.10	2.00	4.70	94.37	93.80	5.40	0.80
	% change	1.5	14.0	50.0	13.8	17.2	14.3	9.9	11.8	107.7	9.4	17.6	37.4	23.7	43.40	66.7	20.5	1.5	2.2	2.7	0
Conventional	Initial	6.6	$1.1x10^{-4}$	0.24	0.74	1.27	0.07	1.77	0.90	0.20	1.04	0.31	2.65	76.90	30.10	1.10	5.10	90.94	89.80	6.40	3.40
	Final	6.7	$0.9x10^{-4}$	0.12	0.68	1.17	0.06	1.38	0.85	0.11	0.78	0.14	2.04	81.40	37.20	0.90	4.40	92.16	91.80	7.40	2.80
	% change	1.5	18.0	50.0	8.0	7.9	14.3	27.0	22.2	45.0	25.0	54.8	23	5.90	23.6	18.2	13.7	1.3	2.2	15.6	17.6
Minimum	Initial	6.7	$1.0x10^{-4}$	0.16	0.53	0.91	0.05	2.15	0.90	0.15	0.87	0.10	2.18	60.10	26.40	1.00	3.30	92.66	91.80	7.40	0.80
	Final	6.8	$0.9x10^{-5}$	0.08	0.91	1.57	0.08	1.56	1.10	0.33	0.78	0.15	2.44	57.60	21.90	1.30	3.60	96.72	89.80	9.40	0.80
	% change	1.5	10.0	50.0	71.7	72.5	60.0	27.0	5.6	120.0	10.3	50.0	11.9	4.2	17.0	30.0	9.1	4.4	2.2	2.7	0

The non-significant differences shown in moisture content at sowing and 10 WAS could be due to the absence of detrimental moisture effects at these two stages for which one treatment probably would have taken advantage over the other as attested to from the weather data (Tables 6 and 7). However, when moisture stress set in, following a dry spell, which occurred at this stage (6 WAS), significant differences emerged with herbicide treatment having more moisture than other treatments probably due to the presence of the decomposing vegetation which was killed with the herbicide under No till-herbicide treatment during seed bed preparation. This decomposing vegetation acted more or less as mulch at this stage. Bulk density which almost followed a similar trend showed no significant difference (P<0.05) at 10 WAS perhaps because of optimum moisture supply (Tables 6 and 7) at this stage. Equally, the significant differences (P<0.05) shown at sowing and 6 WAS may be attributed to the effects of seed bed preparation and the dry spell that occurred at these stages of study. The dry spell might have caused relatively higher moisture loss through evapotranspiration under conventional and minimum treatments than No till-slash and burn and No till-herbicide treatments, resulting in hardening of the soil, and inducement of differences in moisture content and bulk density. The findings support those reported by Lal and Dinkins (23) and Nangju (26). The stability observed in soil texture in slash and burn and to some extent in herbicide and minimum tillage treatments could be linked with the non- and/or less destruction of soil structure during land preparation as compared to that of conventional tillage which usually encourages soil wash and hence deterioration of aggregation. Philips and Young, Jr. (32) and Donahue et al., (8) had earlier advanced similar reasons that no tillage methods do not degrade the soil while tractorization (tillage) damages soil properties like texture and structure particularly if carried out too frequently due to compaction and accelerated organic matter decomposition.

Table 6
Meteorological data for Ibadan during 1993 (May – November) Cropping Seasons (study period)

Month		Total rain-fall (mm)	Total Pan evapo-ration	Mean wind speed (km/hr)	Solar radio-tion (mJ/m²/day)	TEMPERATURE (°c) Min.	Max.	Mean	RELATIVE HUMIDITY (%) Min.	Max.	Mean	No of rainy days
May	a	29.3	32.0	3.6	381.7	21.6	32.8	27.2	59	98	78.5	3
	b	59.0	28.3	4.4	363.6	21.6	30.0	25.8	62	99	80.5	3
	c	50.5	29.0	4.0	368.8	22.2	31.8	27.0	62	98	80.0	3
	d	18.5	23.5	3.9	369.6	20.8	31.4	26.1	65	98	81.5	3
Jun.	a	40.1	29.9	3.7	367.8	22.1	30.7	26.4	66	98	82.0	2
	b	48.3	31.1	3.8	350.0	21.5	30.7	26.1	64	98	81.0	4
	c	33.9	28.4	3.5	253.8	21.0	29.4	25.2	68	98	83.0	2
	d	87.0	24.4	3.0	297.0	21.3	29.4	25.4	70	98	84.0	4
Jul.	a	39.0	21.6	3.5	340.5	19.6	29.5	24.6	69	98	83.5	3
	b	4.5	13.1	4.5	224.6	21.1	27.9	24.5	76	98	87.0	1
	c	1.4	16.8	4.5	239.1	21.3	27.8	49.1	74	97	85.5	1
	d	0.0	20.1	4.0	272.5	21.0	27.9	24.5	69	96	82.5	0
Aug.	a	75.6	17.3	3.0	193.8	21.2	27.4	24.3	78	96	87.0	4
	b	23.1	16.5	2.8	165.1	21.3	27.8	24.6	77	95	86.0	4
	c	1.8	22.3	4.0	313.3	21.0	29.0	25.0	73	96	84.5	1
	d	23.9	18.6	3.3	278.1	21.3	28.6	25.0	75	96	85.5	4
Sept.	a	55.4	22.0	3.5	308.9	20.8	28.8	24.8	76	95	85.5	3
	b	99.4	24.7	2.8	285.8	20.9	29.7	25.3	70	97	83.5	6
	c	31.0	24.7	2.9	347.5	20.8	30.3	25.6	68	96	82.0	3
	d	32.6	24.7	1.9	325.1	20.5	29.8	25.2	67	95	81.0	2
Oct.	a	56.4	22.0	2.3	317.2	20.8	29.9	25.4	67	94	80.5	5
	b	9.2	20.7	2.3	287.8	31.7	22.4	27.1	69	94	81.5	2
	c	72.5	25.1	2.9	336.9	20.0	30.1	25.1	66	94	80.0	5
	d	48.8	24.4	1.6	331.8	22.1	31.1	26.6	67	94	80.5	4
Nov.	a	7.4	26.9	2.2	357.9	21.5	31.1	52.6	63	94	78.5	2
	b	0.0	26.8	2.6	387.2	24.1	32.4	28.3	57	94	75.5	0
	c	0.0	27.8	3.1	326.5	24.9	32.9	28.9	57	93	75.0	0
	d	47.6	14.5	2.7	249.9	23.0	30.7	26.9	68	94	81.0	0

Note: a,b,c,d, = Successive 7 day periods (from date of sowing)
Min = Minimum
Max = Maximum
Rainy day = When rainfall >0.2 mm
Source: Agroclimatology Unit, International Institute of Tropical Agriculture, Ibadan, Nigeria (1993).

Table 7
Summary of Weather Data for 1993 in Ibadan

Month	Total rain-fall (mm)	Total Pan evapo-ration	Mean wind speed (km/hr)	Solar radio-tion (mJ/m²/day)	TEMPERATURE (°c) Min.	Max.	Mean	RELATIVE HUMIDITY (%) Min.	Max.	Mean	No of rainy days
JAN	0.0	182.83	4.3	13.37	18.9	33.6	26.2	25	71	48	0
FEB.	59.0	139.85	4.3	15.13	21.9	34.6	28.2	33	93	63	5
MAR.	177.5	159.47	4.8	15.49	21.8	33.5	27.6	44	90	67	7
APR.	49.3	142.54	4.3	15.47	22.7	33.3	28.0	53	98	75	5
MAY	158.2	124.71	4.0	15.10	21.8	31.8	26.8	61	98	80	10
JUN.	185.1	121.07	3.5	16.05	21.4	30.2	25.8	66	98	82	12
JUL.	135.3	78.12	4.0	10.80	20.8	28.2	24.5	73	97	84	8
AUG.	118.6	85.94	3.4	11.65	21.1	28.3	24.7	76	96	86	14
SEPT.	219.4	104.34	2.4	13.27	20.8	29.9	25.4	68	95	82	16
OCT.	156.7	107.37	2.2	14.96	22.2	30.7	26.5	67	94	81	14
NOV.	50.0	103.82	2.6	14.09	23.7	32.1	27.9	60	94	77	2
DEC.	2.0	117.80	2.2	14.77	20.5	32.2	26.3	50	91	71	1
ANN	1308.1	1467.86	3.5	14.18	21.5	31.5	26.5	56	93	75	94

Note: Min = Minimum
Max = Maximum
Rainy day = When rainfall >0.02 mm
Source: International Institute of Tropical Agriculture, Agroclimatology Unit, Ibadan, Nigeria (1994).

The stability if pH and increase in exchangeable acidity under slash and burn as against increased pH and decreased exchangeable acidity in other treatments could be linked with the alkaline effect of the ash deposited after burning enjoyed by slash and burn treatment over others. Reduction in organic carbon and organic matter contents under slash and burn and conventional treatments as against the increase under herbicide and minimum tillage could be partly accounted for by the burning effects, leaching and/or higher rate of mineralization following soil structure destruction. Total nitrogen wich followed the above trend might be ascribed to loss by volatilization of nitrogen following burning and leaching under slash and burn and conventional tillage, respectively. The general decrease of available phosphorus in all treatments may be linked with leaching, uptake by the crop and a possible fixation in the soil microbial cells. Agboola (1985) and Donahue et al. (8) had earlier made similar observation. The variations observed in base saturation, exchangeable bases and cation exchange capacity for the treatments coud be ascribed to the prescence of ash under slash and burn plot, leaching and differential rates of solubilization among treatments. The differences observed in extractable micronutrients in perhaps due to slight variations in pH values after cultivation. The results are in line with those reported by Agboola (2) and Dinauer (7).

Conclusions

The study revealed that precipitation is a major factor when tillage or land preparation options are to be considered in south western Nigeria. It could be recommended that in zones with moisture deficits and where labour cost is low and its availability assured, zero tillage appears a better option. Conventional tillage seems a better option for farming at commercial scale in areas where adequate precipitation is guaranteed.

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