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SYSTEMES AGRICOLES EN AFRIQUE

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ZONAGE DE LA BASSE CASAMANCE (SENEGAL): UN OUTIL POUR LA RECHERCHE-DEVELOPPEMENT

Mulumba Kamuanga[1], Joshua L. Posner[2] et Made B. Diouf

RESUME

Le zonage de la Basse Casamance (Sénégal) effectué en 1982-83 par une équipe pluridisciplinaire (SPT) de l'Institut Sénégalais de Recherches Agricoles (ISRA), s'est révélé un outil fort utile pour la période d'exécution du projet de recherche. Au-delà des critères agro-climatiques, morpho-édaphiques et socio-culturels usuels, qui décrivent et caractérisent les conditions du milieu, l'équipe SPT avait pris en compte les modes d'exploitation de celui-ci, en vue d'élaborer un zonage qui servirait de cadre de référence aux actions de recherche-développement.

Cette approche a permis d'identifier 5 zones ou situations agricoles en Basse Casamance. Chacune représente un ensemble d'unités spatiales aux potentialités comparables et subissant, en outre, des contraintes homogènes au point de relever d'une même stratégie de développement en termes de thèmes techniques et de vulgarisation. Pour chaque zone, un type d'exploitation agricole dominant était repéré; permettant de cibler ces thèmes et d'en réviser le contenu pendant la mise en oeuvre du programme.

Mots clés: Critères de zonage, unités spatiales, recherche-développement

SUMMARY

Delineation of the Lower Casamance (Senegal) into agricultural zones from 1982-83 by the Farming Systems Research (FSR) team of the Senegalese Agricultural Research Institute (ISRA) proved useful in guiding the execution of the research project. In delineating zones, dynamic criteria concerning farmers' management of their environment were given precedence over more passive criteria such as agro-climatology, morphopedology and socio-cultural practices.

This approach helped identify 5 agricultural zones or situations in the lower Casamance. Each represents a set of spatial units with comparable agro-ecological potential and confronting similar constraints, for which a unique development strategy in terms of research and extension themes could be designed. For each zone, a dominant farm type was also identified, in order to target the themes to special groups and allow an iterative review process during program implementation.

Keywords: Delineation criteria, spatial units, research and development.

INTRODUCTION

Le cycle de sécheresse qui s'est installé au cours de la période 1960-1980, a provoqué des mutations profondes, et imprimé une évolution particulière aux systèmes de production en Basse Casamance. Les paysans ont, de ce fait, mis en oeuvre des stratégies d'adaptation et des mesures d'accommodation à la nouvelle conjoncture climatique. Celle-ci n'a certes pas épargné les autres zones écologiques du Sénégal, mais l'hétérogénéité de son milieu physique et naturel ainsi que les variations dans l'organisation sociale de la production, confèrent à la Basse Casamance une dimension toute particulière.

En effet, malgré l'uniformité de son relief et l'existence d'un groupe ethnique largement majoritaire, les Diola, cette région présente une assez grande diversité d'écosystèmes, étroitement liée au gradient pluviométrique Nord-est/Sud-ouest, à l'influence maritime et aux facteurs historiques et socio-culturels variables. Ces différences sont également visibles au niveau des systèmes de production qui s'échelonnent du Sud au Nord et de l'Ouest à l'Est. L'étude de ces systèmes en Basse Casamance suppose donc qu'on se situe à une échelle d'appréciation différente de celle qu'on adopterait pour l'étude des autres régions plus homogènes du Sénégal (Pélissier, 1966).

En 1982, l'équipe de recherche sur les systèmes de production (SPT) de l'Institut Sénégalais de Recherches Agricoles (ISRA) démarra son programme sur la base du constat de cette diversité du milieu, et de son évolution face à une conjoncture climatique défavorable. Une problématique de recherche est alors définie autour de l'impact du déficit pluviométrique en Basse Casamance, estimé à 30% de la moyenne pour la période 1940-1960 (1 400 mm). Pour une région dont on espérait faire depuis longtemps le grenier du Sénégal, la production céréalière était en baisse depuis 1974, et la région (nettement déficitaire depuis 1978), importait près de 30 000 tonnes par an (SONED, 1983a, 1983b; Jolly, Kamuanga *et al.*, 1985).

En outre, les thèmes de vulgarisation préconisés par le Projet Intégré pour le Développement

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Agricole de la Casamance (PIDAC), n'étaient adoptés que par une minorité de paysans. Au delà des raisons techniques, les facteurs socio-économiques n'étaient pas suffisamment pris en compte. Avant la mise en place de son programme, l'équipe SPT se donna comme priorité de cerner les situations agricoles en Basse Casamance, en vue de définir des thèmes de recherche plus pertinents, et d'adapter aux conditions paysannes des itinéraires techniques développés en station et en adéquation avec les préoccupations des développeurs.

Un triple objectif est poursuivi dans cet article :

- Décrire la démarche de l'équipe SPT pour le découpage de la Basse Casamance en zones agricoles;

- Présenter une typologie fonctionnelle des exploitations agricoles, en dénotant ses liens avec les particularités du système de production qui prévaut dans chaque zone;

- Identifier les implications du zonage et de la typologie des exploitations en matière de recherche et de vulgarisation en Basse Casamance.

I. CADRE NATUREL ET DECOUPAGES ACTUELS

Le Milieu Physique et Humain

La Basse Casamance appartient à un ensemble géoculturel plus vaste, s'étendant de la Gambie à la Côte guinéenne, caractérisé par une "civilisation du riz". Au sein de cet ensemble, les Diola, les Balantes et les Baga se particularisent par leur attachement à la riziculture de bas-fonds sur la mangrove (Pélissier, 1966; Linares, 1970;) Le climat est de type subguinéen, avec une forte influence maritime favorisée par un relief presque plat (50 m d'altitude à l'extrémité Est).

La nature des sols est fonction de leur position sur la toposéquence. Sur le plateau, dominent les sols ferralitiques rouges et les sols ferrugineux tropicaux beiges et lessivés. En bordure des talwegs, des *bolongs* et du fleuve Casamance, on rencontre des sols gris de nappe, sablonneux, (site préféré des palmeraies). Le fond des talwegs sert à la riziculture aquatique. Enfin, viennent les plaines fluviales où l'on rencontre des sols salés (tannes) et les sols potentiellement sulfatés acides qui furent jadis la zone de culture du riz de mangrove (Vieillefon, 1977).

La population rurale en Basse Casamance (3 Départements) qui représente 66% du total, reste très inégalement répartie en raison des densités très variables (Tableau 1). Si l'on exclut les forêts classées et les eaux de surface, la densité rurale atteint 61,4 habitants/km^2 dans le Département de Ziguinchor, 45,3 et 39,6 respectivement pour Bignona et Oussouye. Ces densités, globalement inférieures à celles que l'on rencontre au Sine-Saloum (au moins 60 hab./km^2) auraient diminué sous l'effet des migrations (Pélissier, 1966). Dans les villages suivis par l'équipe SPT en 1985, on a pu estimer que 10 à 36% des actifs se livraient à des migrations saisonnières (ISRA, 1985a).

La population est numériquement dominée (85%) par le groupe Diola et apparentés, dont il existe plusieurs sous-groupes chevauchant le fleuve Casamance. Les Mandingues représentent un groupe minoritaire (5%) mais qui a été historiquement très influent sur les populations Diola de l'Est (Kalounayes) et des zones limitrophes de la Gambie. Par Diola *Mandinguisé*, on désigne ainsi les groupes Diola ayant subi l'influence culturelle des Mandingues à la suite de la domination politique exercée par ces derniers dans certaines parties de la Basse Casamance (Diouf, 1984; Thieba, 1985).

Un des aspects permanents de la *mandinguisation* est la division sexuelle du travail : le Diola ne travaille plus avec les femmes sur les mêmes parcelles. A l'instar des femmes mandingues, l'épouse du Diola *mandinguisé* a la charge exclusive de cultiver le riz dans la vallée. La *mandinguisation* se présente alors comme un paquet culturel qui englobe les aspects sociaux, religieux et techniques.

Découpages Administratifs et Zones de Développement

L'évolution historique du découpage administratif s'est cristallisée autour des affinités socio-ethniques. A l'heure actuelle, ce

découpage administratif reste conforme aux unités socio-géographiques de la région. Il est ainsi possible d'associer chaque arrondissement à un sous-groupe ethnique dominant (tableau 2). Depuis l'indépendance, les efforts de découpage de la Basse Casamance, en dehors de critères socio-ethniques, n'ont été entrepris que par des firmes et bureaux d'études (tels que SATEC, BCEOM, HARZA) dont la plupart ont mis l'accent sur des critères morpho-édaphiques, topographiques et hydrologiques dans le cadre des aménagements hydro-agricoles (HARZA, 1984).

Au début des années 80, avec la vulgarisation des thèmes sur l'agriculture intensive (semis direct du riz, maïs en plein champ, traction animale, etc.), la Société de Mise en Valeur de la Casamance, (SOMIVAC), agence de développement, a procédé à un découpage de la région en zones de développement. En plus des critères agro-climatiques, morpho-édaphiques et socio-ethniques usuels, des villages ont aussi été regroupés en zones, "ouvertes" ou non au progrès.

Pris individuellement, chacun de ces découpages ne pouvait satisfaire aux exigences d'une recherche agricole appliquée. Au delà de la description et de la caractérisation des conditions du milieu, l'équipe SPT a pris en compte les modes d'exploitation, en vue d'élaborer un découpage de référence pour la mise au point des itinéraires techniques appropriés, et pour l'identification des zones d'adoption des innovations.

II. SITUATIONS AGRICOLES ET TYPES D'EXPLOITATION

Démarche et Critères

Un premier découpage de la Basse Casamance avait été entrepris, suite à des enquêtes exploratoires (février-juin 1982) et après l'examen des cartes administratives, pédologiques, ethniques ainsi que les zonages antérieurs (ISRA,1983). Trois critères principaux (division sexuelle du travail, implantation de la traction animale et importance du riz aquatique), ont permis de subdiviser la Basse Casamance en 5 zones ou situations agricoles. Des enquêtes sociologiques initiées en 1983 sur le fonctionnement des groupes familiaux et la localisation des groupes ethniques, ont contribué à préciser davantage les limites entre zones. En 1985, une révision complète du zonage a discerné les aspects à caractère permanent, de ceux plus conjoncturels (période de sécheresse).

Entre 1982 et 1984, des enquêtes socio-économiques réalisées au niveau des unités de production, portant sur les structures, l'utilisation de ressources et les modes d'organisation de la production, ont permis de souligner l'importance des relations ménages-concession, et de mieux cerner la notion d'exploitation agricole dans chaque zone. Un suivi pluriannuel a été assuré dès 1983, après un choix judicieux de 10 villages (2 par zone) et de 150 exploitants (15 par village). Une typologie des exploitations basée sur leur mode de fonctionnement a été élaborée et a facilité une meilleure différenciation des situations agricoles.

Les trois critères qui ont permis le découpage de la Basse Casamance en cinq zones agricoles sont décrits ci-après:

a. Division sexuelle du travail

Ce critère oppose deux systèmes différents d'organisation sociale du travail en Basse Casamance. L'axe nord-sud, le long de la ligne Djibidione-Bignona-Ziguinchor, sépare le système Diola traditionnel (originaire des vasières d'Oussouye et de Guinée Bissau) du système dit Diola *mandinguisé* (qui tire son origine des pratiques culturales du plateau du Mali). Dans le premier système, hommes et femmes travaillent ensemble sur toute la toposéquence, exécutant les tâches complémentaires et spécialisées (labour pour les hommes, repiquage, sarclage et récolte pour les femmes). Dans le deuxième (Mandingues et Diola *mandinguisés*), on retrouve une spécialisation des lieux de culture: les hommes cultivent le plateau (arachide, mil, sorgho, maïs), tandis que les femmes assurent toutes les opérations culturales du riz dans les bas-fonds (on parle de riziculture féminine).

b. Implantation de la traction animale

L'emploi des boeufs pour le labour et le transport attelé cons-

tituent un critère puissant qui démarque les systèmes de production au Nord et au Nord-Est de ceux du Sud-Ouest de la région de Ziguinchor. L'implantation de la traction bovine a été plus tardive en Basse Casamance, que dans les autres régions du Sénégal. Les exploitants se sont progressivement équipés en matériels de culture attelée, par l'intermédiaire du Programme Agricole (Crédit arrêté depuis 1970) ou à partir de la Gambie. En 1982, au moment de la mise en place de l'équipe SPT, la culture attelée avait pénétré, le long d'un axe Nord-Sud, jusqu'à la latitude du marigot de Bignona (Whitney, 1983).

c. Importance du riz aquatique

Tous les paysans de Casamance gèrent leur autosuffisance en céréales en fonction de leur situation géo-écologique. En pays Diola traditionnel du Sud-Ouest, l'accent est mis sur le riz repiqué. Du Sud-Ouest au Nord-Est dans le sens du gradient pluviométrique décroissant, le riz aquatique cède progressivement la place aux céréales de plateau (dont le riz de plateau) tant au niveau des surfaces cultivées que dans les habitudes alimentaires.

La figure 1 représente les 5 situations agricoles en Basse Casamance. Le tableau 3 offre une description synoptique de chaque zone en l'état actuel de nos connaissances. Chaque situation représente un ensemble d'unités spatiales aux potentialités comparables, subissant en outre des contraintes homogènes, au point de relever d'une même stratégie de développement en terme de thèmes de recherche et de vulgarisation (ISRA, 1985b).

Les Zones à Organisation Sociale Diola (I, II, V)

a. Caractéristiques communes et différences

Les sociétés traditionnelles d'Oussouye, du Blouf et du Fogny-Combo possèdent des règles communes d'organisation et de gestion de l'écosystème, dont certaines caractéristiques peuvent changer, en fonction des stratégies mises en oeuvre pour s'adapter à la conjoncture climatique et économique. Parmi les caractéristiques communes, on peut retenir notamment :

- l'autonomie du couple et l'affectation des terres au moment du mariage. Il s'agit d'une autonomie agricole et financière au niveau d'une famille restreinte (ménage, famille nucléaire) généralement monogame et qui constitue l'unité de production (ou exploitation).

- la conjugaison des travaux de l'homme et de la femme sur les mêmes parcelles de cultures. C'est une division du travail par tâche agricole, qui réserve les tâches lourdes aux hommes.

- l'omniprésence du *cayendo*, outil de labour séculaire pour le travail des rizières et des terres exondées. Ce labour est généralement fait en billons dans l'ensemble des zones Diola traditionnels.

- la préoccupation constante du riz, surtout la culture du riz aquatique pour laquelle le patrimoine foncier est géré de façon à garantir une production suffisante, à moins d'une calamité ou autre malchance passagère. Comme le note Pélissier (1966), pour les Diola (traditionnels) "Manger, c'est manger du riz et c'est être au dernier degré de la misère que de ne pas en consommer pendant une seule journée".

- un taux de migration élevé (18% en moyenne) attribuable à une série de causes dont: l'émancipation économique précoce des jeunes en quête de revenus monétaires; la contrainte foncière plus aiguë dans les villages essentiellement axés sur la riziculture aquatique, et la forte attraction qu'offre la Gambie pour les transactions commerciales (Tableau 2). Dans les zones *mandinguisées*, ce taux est faible (5,6%) en raison de la prise en charge des jeunes par le groupe domestique, du contrôle des mouvements des jeunes, et de l'influence des comportements liés à la religion islamique.

Des différences existent à l'intérieur des zones traditionnelles Diola, notamment au niveau de l'autonomie résidentielle, de la mise en valeur des terres et de l'importance des céréales de plateau. Ainsi dans la zone I (Oussouye, Bandial et Bayotte), le ménage en tant qu'unité économique de base, se libère aussi sur

le plan résidentiel en fondant sa propre demeure. Il reste toutefois la composante d'une unité foncière à un niveau de segmentation supérieur, gérée par le plus âgé, qui dispose d'un droit de regard sur les terres malgré leur affectation individuelle. Danscette zone presqu'entièrement peuplée d'animistes, l'élevage porcin et la récolte du vin de palme, constituent également des éléments de différenciation par rapport aux zones II (Blouf) et V (Fogny-Combo) converties à l'islam. Dans ces dernières, le couple perd le plus souvent son autonomie résidentielle au profit d'un habitat collectif, qui regroupe plusieurs ménages à l'intérieur d'une concession. Ici, l'unité foncière coïncide avec l'unité de résidence. Le chef *anifanaaw* gère les terres transmises au sein du patrilignage. Le ménage conserve, comme dans la zone I, son autonomie agricole et sa liberté de gestion et d'accumulation pour ce qui est des petites espèces animales (ISRA, 1984).

Pour ce qui est de la mise en valeur des terres, il faut noter la disponibilité inégale en rizières profondes et le degré d'implantation de la traction animale. Il y a moins de rizières aquatiques profondes dans le Blouf (zone II) qu'à Oussouye (zone I). Le Blouf exploite relativement moins de plateaux qu'au Nord-Ouest (zone V), ce qui rend son système de production comparativement bloqué (Posner et al., 1985). Plus au Nord et vers l'Est, il y a très peu de rizières aquatiques basses (Tableau 4). Oussouye et Blouf sont encore en culture manuelle. En résumé, le type d'habitat apporte sa marque de différence au sein des zones Diola. La riziculture aquatique reste encore une préoccupation majeure : c'est la contrainte foncière et les aléas climatiques qui conditionnent sélectivement sa réussite et son essor. L'utilisation de la traction animale différencie davantage la zone I au Sud-Ouest de la zone V au Nord du fleuve. Si le *cayendo* reste l'outil principal du labour, l'utilisation d'instruments d'origine mandingue se généralise dans les zones du Nord, suite aux contacts avec les mandingues voisins de Gambie et de Moyenne Casamance.

b. Types d'exploitation en pays Diola

Au niveau des unités de production, les caractéristiques communes aux zones Diola se traduisent aussi par un type d'exploitation dominant avec deux variantes selon les particularités locales. L'exploitation typique (dominante) coïncide avec le ménage *butong*, qui jouit d'une autonomie résidentielle *eluf* et agricole (fig. 2). De ce fait, la population totale de l'exploitation correspond normalement au nombre de résidents d'une famille nucléaire : en moyenne, 7 personnes dont 4 actifs. Ainsi à Boukitingo, 80% des exploitations recensées comportent un seul ménage, et cultivent 1 ha en moyenne, dont près de la moitié en riz. Le reste est principalement affecté à l'arachide et aux cultures mineures (patates douces, manioc, maïs de case etc). L'unité de production agricole en zone I se superpose aussi à l'unité de production animale notamment en ce qui concerne les animaux intégrés (petits ruminants et porcins).

Variante Ia (type Bandial) : Cette exploitation agricole diffère de celle d'Oussouye, par son système de culture axé principalement sur la riziculture aquatique (surface cultivée d'environ 1 hectare). Pour Seleky par exemple, l'exploitation compte 4 actifs et ne cultive que du riz. Sur le plan du fonctionnement, l'originalité du Bandial repose sur deux aspects : d'une part la transmission des terres aussi bien aux hommes qu'aux femmes, et d'autre part l'importance de la pêche, qui mobilise les hommes pour une campagne saisonnière de 6 à 8 mois.

Variante Ib (type Blouf) Elle se distingue de la dominante par l'habitat collectif libre, reflet de l'appartenance à une unité foncière au niveau du lignage, et un ratio surface plateau/rizières plus élevé, dont la répartition moyenne est de 57% pour l'arachide, 8 à 10% pour les céréales et 34% pour le riz. La présence de la traction animale dans le Fogny-Combo (zone V) explique la dimension généralement plus grande des surfaces cultivées (3,3 ha en moyenne).

Les Zones Diola Mandinguisées

a. Caractéristiques communes et différences.

Du phénomène de *mandinguisation* découlent certains aspects communs aux zones III et IV. Les plus importants sont l'islamisation des populations, la transformation des structures de l'habitat et l'organisation familiale de la production autour de la concession, l'adoption d'instruments de labour d'origine mandingue (*fanting, donkouton, daba*), la préoccupation de cultiver l'arachide (Tableau 5), un type d'élevage caractérisé par la présence de toutes les espèces à l'exception des porcins, et l'usage de la langue mandingue.

Il est cependant important de nuancer certains de ces aspects. Si toutes les zones Diola *mandinguisées* ont adopté l'islam, l'islamisation ne s'est pas partout accompagnée d'une *mandinguisation* (cas du Blouf (Diouf, 1984)). Islam et mandinguisation ont progressé rapidement, la durée d'une génération, dans les parties de la Basse Casamance les plus directement en contact avec les mandingues (à savoir les Kalounayes, l'arrondissement de Sindian, de Niaguis et la frange frontalière de la Gambie au nord de Diouloulou). Parmi les facteurs de différenciation, il faut noter l'implantation et le développement de la culture attelée dans la zone IV (Kalounayes) par rapport à la zone III (Niaguis). Cette dernière, zone pionnière et cosmopolite qui a reçu non seulement des immigrés de la Guinée Bissau, mais aussi des Peulhs et des Diola originaires du Blouf et du Bandial, est constituée de deux territoires où la pression foncière est très forte. Puisqu'on est en présence d'une organisation de la production de type mandingue, on pourrait s'attendre à ce que le système de culture dans la grande partie de Niaguis évolue vers le type de Sindian-Kalounayes (zone IV) dès que la traction animale s'y implante.

b. Types d'exploitation en pays Diola *Mandinguisé*

La dominante (type II) est représentée par l'exploitation de la zone de Sindian-Kalounayes, caractérisée par un habitat collectif centralisé (fig. 3). La production agricole s'organise au niveau de la concession, *elupeey*, qui constitue généralement une unité foncière et regroupe plusieurs ménages : frères cadets du patriarche, ses fils et ceux de ses frères, les enfants des uns et des autres, ainsi que leurs épouses respectives. Ceci explique la taille assez grande de l'exploitation, en moyenne, 11 personnes dont 8 actifs. La surface cultivée est de 6,2 ha dont près de 60% en arachide, 8% en riz et 20% en mil ou sorgho. Le contrôle économique du chef de concession s'exerce aussi sur la production bovine. Le groupe de production des femmes est organisé autour des cuisines. L'unité de production agricole ne correspond pas à l'unité de production animale.

Variante IIa (type Niaguis) : L'absence de la traction animale est la principale différence avec l'exploitation de Sindian-Kalounayes. De ce fait, la surface totale cultivée est relativement faible (2,5 ha en moyenne). Les surfaces cultivées en riz et en arachide sont équivalentes.

Variante IIb (type Toukara) : A Toukara, les principales caractéristiques portent sur le niveau du fonctionnement, par l'accès des femmes aux céréales de plateau qu'elles cultivent sur des parcelles individuelles (due à l'assèchement des rizières) et par une évolution vers l'autonomie agricole de certains ménages au sein de la concession. Ce dernier phénomène, vraisemblablement dû à une faible *mandinguisation*, explique en partie la taille relativement réduite des exploitations (5,3 ha et 5 actifs en moyenne). L'habitat n'impose pas aux jeunes ménages de travailler sous le contrôle de l'*anifanaaw*, bien que l'unité domestique corresponde à l'unité foncière dont ce dernier est le gestionnaire.

ACTIONS DE RECHERCHE ET PERSPECTIVES DE DEVELOPPEMENT

Le découpage de la Basse Casamance en situations agricoles et l'analyse du fonctionnement des exploitations avaient permis à l'équipe SPT de mieux définir le contenu des actions de recherche-développement, avant et pendant la mise en oeuvre du programme. Dans l'ensemble, ces actions ou propositions visaient à résoudre une problématique clairement appréhendée dès 1982 : la résorption du déficit vivrier en Basse Casamance.

Trois thèmes fédérateurs avaient été ainsi développés, sur la base du diagnostic des contraintes en milieu paysan : intensification de la production sur les terres productives; diversification du système de culture, valorisation de l'humidité résiduelle dans les rizières du Sud. L'évaluation des technologies avec la participation des paysans, devrait permettre de définir les priorités de recherche en amont, et l'identification des interlocuteurs et groupes cibles pour le développement en aval, à la suite des résultats d'enquêtes socio-économiques.

L'effort d'intensification a visé l'amélioration de la productivité des terres et du travail. Dans les villages du Nord (zones IV et V), l'accent a porté sur les cultures exondées et l'utilisation rentable de la traction animale. Des essais de fertilisation du maïs, de l'arachide et du riz de nappe ont été mis en place, à des doses compatibles avec le niveau de technicité et le pouvoir d'achat paysan. Pour le riz de nappe en particulier, l'efficacité et la rentabilité sélectives de l'engrais ont été étudiées, en fonction de la nature du sol et de la position des rizières sur la toposéquence. L'organisation sociale de la production dans ces villages de Diola *mandinguisés* (riziculture féminine) ayant favorisé le développement du semis direct du riz, son adoption s'accompagnait d'une demande accrue de main d'oeuvre pour le désherbage. Des essais de sarclage mécanique (à la charrue UCF) et l'emploi des herbicides en rizières de nappe (zone III proche des centres urbains) ont été conduits avec des résultats probants. Dans les zones où la traction animale est développée, l'expérimentation a porté sur le semoir à deux rangs. Dans la zone rizicole au sud du fleuve (ZoneI, Oussouye), l'intensification a visé l'amélioration de la productivité du riz repiqué, par les essais de fertilisation et de comportement variétal, indiqués seulement pour une étroite ceinture de rizières douces. Malgré la performance de quelques variétés (DJ6-48D, IR-8, IR-442), l'accent en riziculture aquatique a dû porter sur l'amélioration du milieu physique (petits barrages anti-sel, drainage). En culture de case, l'effort a été concentré sur le maïs, dont les rendements pouvaient atteindre 2 000 kg/ha avec le labour en billon et la fertilisation adéquate. Dans la zone III (Blouf), l'augmentation de la production du riz passe par la résolution des problèmes fonciers et démographiques.

La diversification du système de culture dans les zones du Nord (IV, V) a porté sur une utilisation efficace du calendrier agricole, en y insérant des cultures telles que le sorgho semé en août et le niébé dérobé dans le maïs, sans trop surcharger l'emploi du temps des paysans, à la fin du sarclage des arachides. Dans la zone rizicole du Sud (I, II), la diversification a visé la réduction du risque de famine au cours d'une année sèche, quand le riz aquatique ne réussit pas. Dans cette optique, le travail de l'équipe a porté sur le niébé et les patates douces, comme cultures de rattrapage. Les résultats des tests en milieu paysan indiquent des rendements de l'ordre de 500 kg/ha pour le niébé (variété 58-57) et 5 000 kg/ha pour les patates (variété Ndargu). Le manioc et le niébé ont été proposés pour remplacer le riz dans les rizières hautes abandonnées. Valoriser l'humidité résiduelle des rizières ne s'est appliquée qu'aux villages de la zone sud (I, II). La patate douce a été testée à Oussouye, comme culture de contre-saison repiquée dans les rizières de nappe à la mi-octobre, ou dans les rizières aquatiques dès la fin de janvier.

Enfin, dans les zones Diola (I, II), les résultats des enquêtes ont indiqué, que le chef de ménage reste l'interlocuteur privilégié des agents de développement, car l'exploitation agricole fonctionne sur le modèle de famille nucléaire. En revanche, chez les Diola *mandinguisées*, il faut considérer deux catégories d'interlocuteurs, le patriarche *anifanaaw* pour les cultures de plateau, et l'épouse la plus âgée, (responsable du groupe de femmes) pour la riziculture.

CONCLUSION

Cette étude a démontré que pour une région relativement limitée, assez peuplée et très diversifiée comme la Basse Casamance, le découpage en zones agricoles ayant des caractéristiques semblables, a permis à la Recherche-Développement de mieux cibler

sa clientèle et donc l'éfficacité de ses propositions.

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Tableau 1. Densité de Population Rurale.

Département	Arrondissement	Population	Surface totale (km^2)	Surface ferme[1]	Densité au km^2 Surface totale	Densité au km^2 Surface ferme
Oussouye	Loudia-Ouolof	17 279	517		33,4	
	Kabrousse	10 368	374		27,4	
Total		27 647	891	698	31,2	39,6
Ziguinchor	Niaguis	27 138	692		39,2	
	Nyassia	14 585	461		31,6	
Total		41 723	1 153	680	36,2	61,4
Bignona	Diouloulou	30 929	1 803		16,4	
	Sindian	42 670	1 437		29,7	
	Tenghory	36 968	1 073		34,5	
	Tendouck	40 709	902		45,1	
Total		151 276	5 295	3 336	28,0	45,3
Région de Ziguinchor		220 646	7 339	4 714	31,8	48,8

Source: HARZA, 1984; Bonnefond et Loquay, 1985.

Note: [1] sans forêt classée ni eaux de surface.

Tableau 2 Situations Agricoles en Basse Casamance: Caractéristiques Démographiques

Zones	Arrondissement	Ethnies dominantes	Population totale	Densité au km^2	Taux de migration saisonnière[1]
I Oussouye	Kabrousse	Diola-Kassa (70%)	10 368	33	34,2%
	Loudia-Ouolof	Diola-Kassa (98%)	17 279	33	34,2
	Nyassia	Diola-Bandial (90%)	14 585		
		Bainouck-Bayot (10%)	Total 42 232		
II Blouf	Tendouck	Diola-Blouf (92%)	Tot. 40 709	44	11,3%
III Niaguis	Niaguis	Diola (26%)			
		Mandingue (13%)			
		Manjak (16%)			
		Autres (45%)	Total 27 138	46	6,1%
IV Sindian	Sindian	Diola-Fogny (93%)	42 670		
Kalounayes	Tenghory	Diola-Fogny (80%)	36 968		
		Mandingue (5%)	Total 79 638	33,2	5,2%
V Fogny-Combo	Diouloulou	Diola-Fogny-Combo (77%)	30 929	17	11,3%
		Mandingue (12%)			

Source : SOMIVAC - PIDAC 1985, Rapports Annuels Equipe SPT, ISRA/Djibelor

[1] Valeurs moyennes compilées au départ des sources différentes pour les années 1979-80 Van hoe (1972), de Jong et al, 1976 ; BCEOM-IRAT, 1979, cités par HARZA (1984).

Tableau 3. Situations Agricoles en Basse Casamance[1]
Caractéristiques des Agro-Systèmes

Zones Agricoles	Pluviométrie Moyenne (mm)	Culture Dominante (% surf. tot)	Organisation de la Production	Equipement en paires de boeufs % total en BC	Superficie totale/zone (km^2)	Superficie Moyenne/expl. (ha)[4]	Occupation du sol (% surf. totale)
I Oussouye	1 083	Riz (80) Arachide (14)[2] Mil/Sorgho/Maïs (3)	Hommes et femmes: plateaux et rizières	0,3	1 352	1,2	Forêt (18%); Mangroves et tannes (22); Vallée dégagée (23)
II Blouf	908	Arachide 952) Riz (25) Mi/Sorgho/Maïs (17)	Hommes et femmes: plateaux et rizières	6,9	902	1,4	Mangrove et tannes (26); Cultures sèches,jachère (27) Vallée dégagée (12); Savanes (14)
III Niaguis	958	Arachide (36) Riz (25) Mil/Sorgho/Maïs (30)	Riziculture féminine	2,6	692	2,3	Forêt (39); Cultures sèches (30) Savane (7) Vallée dégagée (15)
IV Sindian Kalounayes		Arachide (55) Riz (15) Mil/Sorgho/maïs (30)	Riziculture féminine	69,4[3]	2 510	6,2	Forêt (39); Cultures sèches, jachère (24); Vallée dégagée (12)
V Fogny-Combo	698	Arachide (59) Riz (32) Maïs/Sorgho/Maïs (8,5)	Hommes et femmes: plateaux et rizières	20,5	1 883	3,4	Forêt (31); Mangrove et tannes (29); Vallée dégagée (13); Cultures sèches et jachère (12)

Source: SOMIVAC-PIDAC; Rapports Annuels, Equipe SPT, ISRA, Djibelor

[1] Les zones de suivi du PIDAC (14) ont été regroupées pour correspondre au découpage de l'équipe SPT.
[2] Pour l'arrondissement de Loudia-Ouolof, les surfaces en arachide représentent près de 50% du total cultivé.
[3] Chiffres corrigés.
[4] Les superficies par actif sont respectivement: 1,2; 1,4; 2,3; 6,2 et 5,4 pour les zones I, II, III, IV et V.

Tableau 4 Pourcentage de surface cultivée par culture principale en zones Diola Traditionnelles[1]

Zone	Village	Riz Aquat.	Riz de nappe	Céréales de plateau[2]	Arachide	Autre[3]
I	Loudia-Ouolof	45	0	3	43	9
	Boukitingo	36	0	8	52	4
	Mahamadou	16	2	4	61	17
	Seleky	100	-	-	-	-
II	Tendimane	0	25	14	54	7
V	Bandjikaki	12	1	19	61	7
	Suel	1	7	22	66	4

[1] 3 ans de suivi de 15 exploitations par village

[2] Riz de plateau, mil, sorgho, maïs

[3] Manioc, patates douces, niébé, jardins potagers.

Tableau 5 Pourcentage de surface cultivée par culture principale en zones Mandinguisés[1]

Zone	Village	Riz Aquat.	Riz de nappe	Céréales de plateau[2]	Arachide	Autre[4]
III	Boulom	24	19	21	24	12
	Maoua	5	20	26	46	3
IV	Boulandor	1	15	27	56	1
	Medieg	3	10	31	56	0
	Toukara[3]	-	-	56	32	12

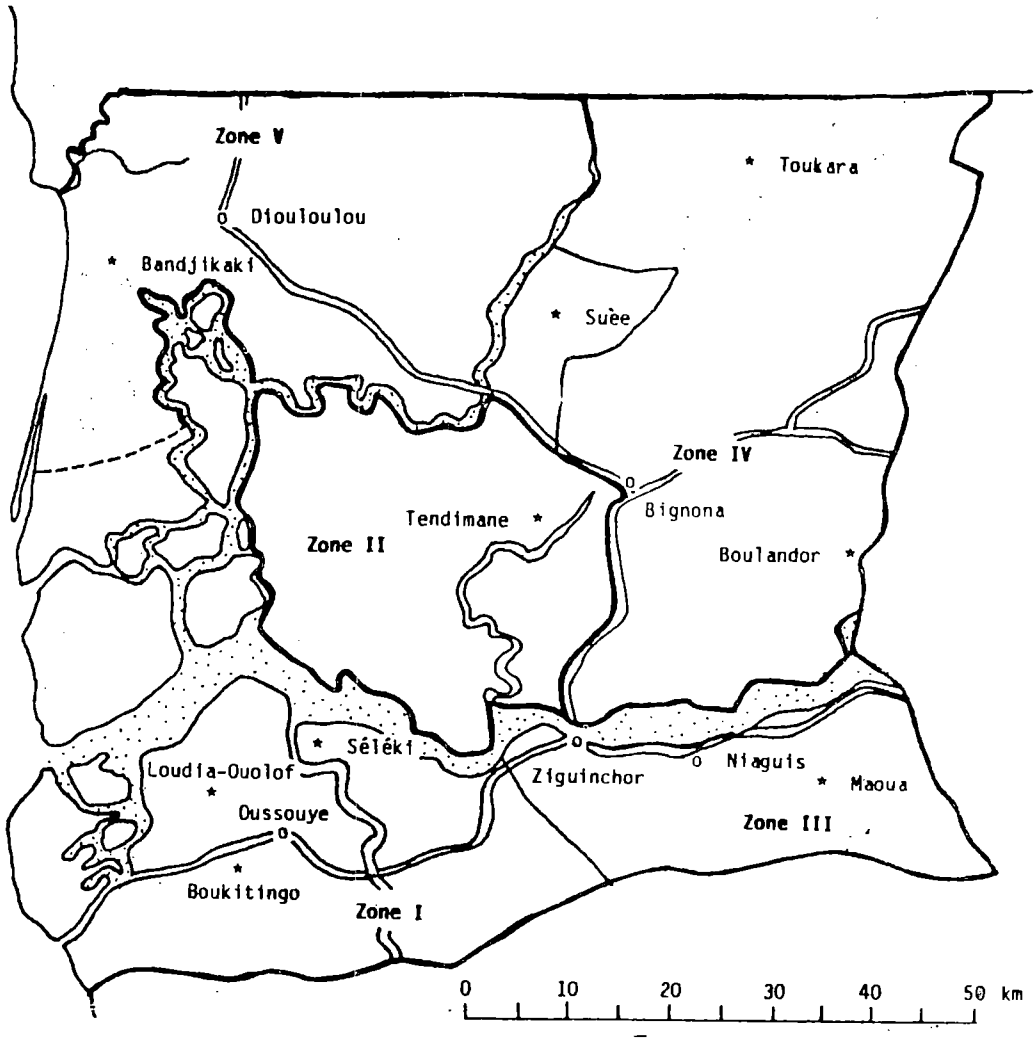
[1] Moyenne de 2 ou 3 ans de suivi selon le village. Selon le village, il y avait deux ou trois ans de suivi de
15 exploitations. A Selekey et Toukara une seule année de 6 exploitations.

[2] Riz de plateau, mil, sorgho et maïs.

[3] Suivi de 6 exploitations pour deux ans.

[4] Manioc, patates douces, niébé, jardins potagers.

Figure 1 : Zones Agricoles de Basse Casamance



LEGENDE

I Organisation sociale type Diola: riz repiqué dominant; pas de traction bovine

II Organisation sociale type Diola: riz repiqué et semis direct des céréales importants; pas de traction bovine.

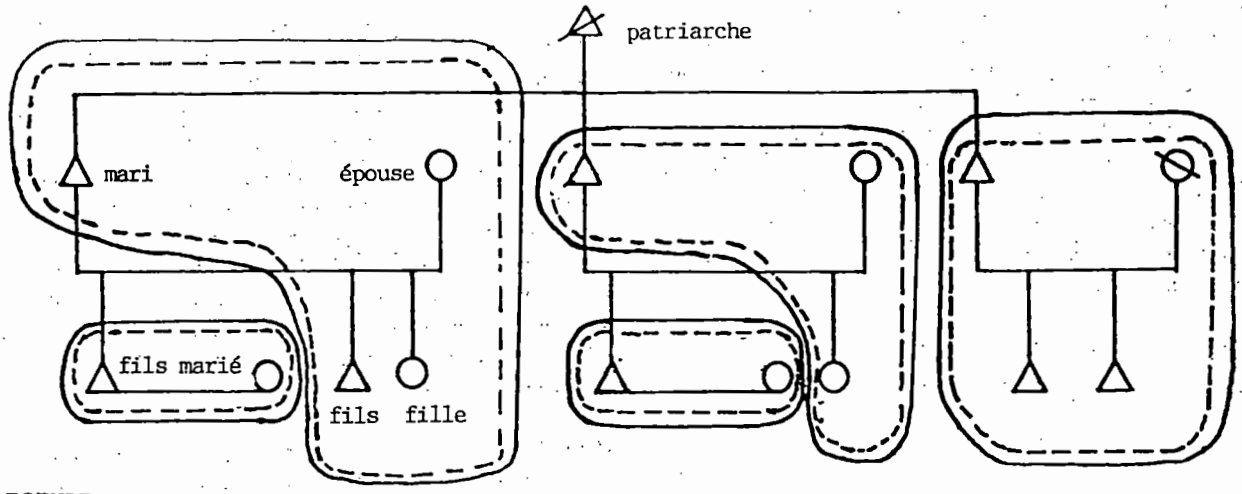
III Organisation sociale type Mandingue dominante: semis direct des céréales important; très peu de traction bovine.

IV Organisation sociale type Mandingue: semis direct des céréales dominant; bien équipée en traction bovine.

V Organisation sociale type Diola dominante: riz repiqué et semis direct des céréales importants; moyennement équipée en traction bovine.

Figure 2: Exploitation agricole type I
(Oussouye): Habitat individualisé.

UN ASPECT DE LA SEGMENTATION D'UN LIGNAGE A BOUKITINGO

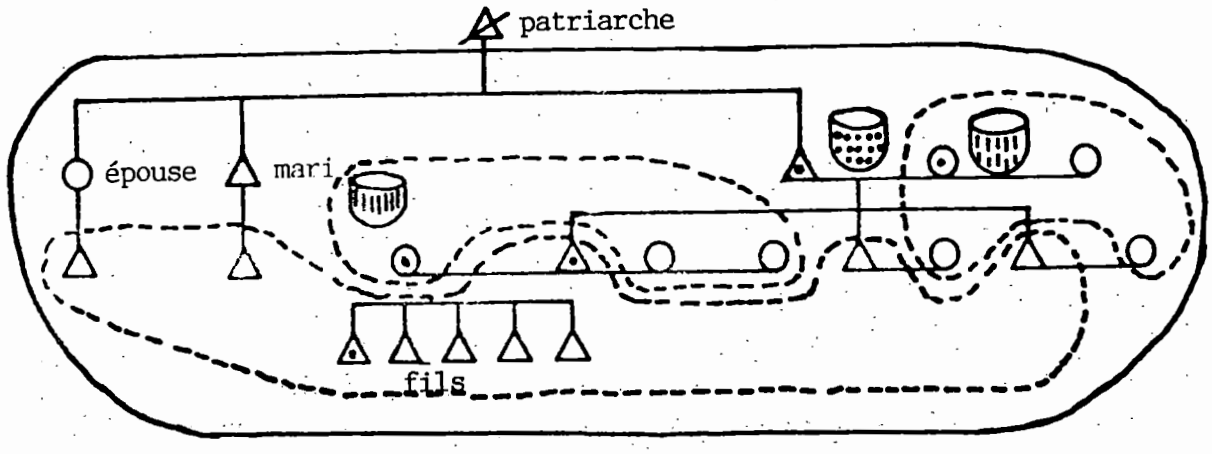


LEGENDE

——— Limite résidentielle des ménages

– – – – Espace économique des ménages = Unité de production

Figure 3: Exploitation agricole type II
(Diola Mandinguisé): Habitat Collectif d'une concession (*elupeey)*



——— Limite de l'unité résidentielle

– – – – – Limites des équipes de production

Grenier des hommes (produits céréaliers du plateau)

Grenier de riz des femmes

Anifanaaw, chef de Concession et chef d'exploitation

Fils aîné et responsable de l'équipe masculine.

Responsable d'un groupe de production chez les femmes.

GOVERNMENT POLICY AND FARM LEVEL TECHNOLOGIES: THE EXPANSION OF SOYABEAN IN NIGERIA.

Joyotee Smith[1], James B. Woodworth[1] and Kenton E. Dashiell[1]

SUMMARY

The paper demonstrates the importance of government policy in farming systems research. Taking the case of soyabean in West Africa it documents how repeated attempts to introduce soyabean met with limited adoption until a domestic processing industry developed in response to changes in government policy. Analysis of the impact of policy measures on farm level incentives should therefore be an integral part of farming systems research. The paper also demonstrates that distortions in the policy environment can lead to crop expansion. Social profitability considerations, and not adoption alone, should be taken into account before farming systems practitioners promote technologies.

Keywords: Government policy, farming systems research, soyabean, domestic processing industry, social profitability.

RESUME

Cet article décrit l'importance de la politique gouvernementale dans le cadre de la recherche sur les systèmes de production. Prenant le cas du soja en Afrique de l'Ouest, il illustre comment les efforts renouvelés en vue d'introduire le soja dans les systèmes de production ont connu un succès limité jusqu'à ce qu'une industrie locale de transformation ait vu le jour en réponse aux changements dans la politique du gouvernment. Pour cette raison, une analyse de l'impact de la politique du gouvernment devrait faire partie intégrante de la recherche sur les systèmes de production. Cet article prouve également que des distorsions dans l'environnement politique peuvent conduire à une expansion des cultures. Des considérations, non seulement d'adoption mais aussi de rentabilité sociale devraient être prises en compte avant que les practiciens de la recherche-système ne promeuvent les technologies.

Mots clés: La politique du gouvernment, systèmes de production, soja, industrie locale de transformation, rentabilité sociale.

INTRODUCTION

It has long been recognized that the development of adoptable technologies for small-scale farmers in developing countries requires an understanding of farmers' conditions and priorities. Farming Systems Research is the tool most widely used for obtaining these insights. Farming Systems practitioners have however mainly focused their analyses at the level of the farm, and ignored factors, such as government policy, which occur at higher system levels. This paper reinforces this point by documenting the relationship between government policy and the expansion of soyabean *F. Glycine Max (L.) Merr.* in Nigeria. The paper illustrates how technologies which appear to be appropriate when viewed from the perspective of the farming system are unlikely to be adopted if the policy environment is unfavorable. It also illustrates that technology adoption may occur because of distortions in the policy environment which provide incentives for adoption. Farming Systems researchers should therefore consider the social profitability of technologies before promoting them at the farm level.

Soyabean's potential contribution to the farming systems of West Africa has long been recognized. A major focus of farming systems research in the region is to diversify the arable cropping system away from the domination of cereals in the savanna, and root and tubers in the forest zone. The objective is to prevent the build-up of biotic and abiotic constraints specific to the dominant crops, improve nutrition of farm families and diversify income sources. Leguminous crops are currently perceived to have the best potential for achieving this objective (COMBS, 1992). Among the grain legumes interest has often centered on soyabean because biophysically it is well adapted to the region, it can produce acceptable yields with minimal levels of material inputs, contains 40% high quality protein and has the potential to be developed into a cash crop for producing animal feed and edible oils.

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Recent data indicate that soyabean can also contribute to the control of cereal pests such as *Pratylenchus* nematode species (Webber *et al*, forthcoming). Production, industrial processing and home consumption of soyabean is however very limited in West Africa as a whole. Repeated attempts to introduce soyabean into the region's farming system have resulted in very limited adoption. In the absence of a developed market some projects attempted to induce soyabean adoption by guaranteed purchase of production. This was done, for example, in Alabata, Igangan and Ikoyi in South-West Nigeria and in the Kasai region of Zaire (Mutsaers, 1991; Osho and Adjebeng-Asem, 1991; Shannon and Mwamba, 1992.). Another approach was to introduce farmers to methods of incorporating soyabean into local diets, as was done in Ayepe in South-West Nigeria and in the Kasai region of Zaire (Mutsaers, 1991; Shannon and Mwamba, 1992). Schemes for guaranteed purchases have proved unsustainable in the absence of established markets. Production for home utilization has usually led to sustained and slowly increasing adoption. Production levels have however remained very small. Shannon and Mwamba (1992) reported an average production of 75kg by soyabean growers in Kasai. The average size of soyabean plots in Ayepe was 0.03 ha (Mutsaers, 1991). The major constraint to the expansion of production was identified by farmers as the lack of a market. In this context reports of a dramatic expansion in soyabean production in Benue State, Nigeria, has created much interest among farming systems practitioners. Documentation of the expansion and reasons for its occurence are given below.

History of soyabean production in Benue State, Nigeria

Benue State is situated in eastern Nigeria about 300km inland from the Atlantic Ocean (Fig. 1). It is in the Southern Guinea Savanna ecological zone and has a bimodal rainy season starting in early April and ending in late October. The average rainfall is about 1400 mm per year, and the region consists of ferruginous tropical soils.

Soyabean was first introduced to the Tiv tribe, in the eastern part of Benue State, by British colonists in the 1940s as an export crop. There was little or no effort to promote soyabean processing or its consumption by the local populace.

At the time of independence (1960), there was a traditional domestic market for palm and groundnut oil, which was met by village level processing. Nigeria was also a major exporter of edible oils, groundnut and palm kernel. Soyabean, however, was exported unprocessed. In the late 1960s the civil war in Nigeria severely disrupted internal transport of agricultural commodities. This led to a sharp decline in exports of soyabean and palm oil.

In the mid-1970s, the petroleum boom increased domestic demand for edible oil and livestock products which was met increasingly from substantial quantities of imports. Average annual imports of oils and feed cake between 1972 and 1986 were 137,000 t and 48,000 t respectively, including 500,000 t of soy oil (FAO Trade Year Book). The Nigerian currency (Naira) also became highly over-valued during this period. This reduced the competitiveness of locally produced products. Soyabean exports ceased. Nigeria converted from an exporter to an importer of edible oils. Domestic production of groundnut and palm oil continued, presumably because of rural demand which could most conveniently be met from village level processing. Since soyabean oil was not consumed in rural areas, and since village level technologies for processing soyabean oil did not exist, the demand for soyabean fell to minimal levels. There was a small localized market for soyabean in Kafanchan in Northern Nigeria for the production of a local seasoning (*daddawa*), the main ingredient of which was locust bean (*Parkia clappertonia and P. filicoides*). In the late 1970s *daddawa* producers started substituting soyabean for locust bean. This helped to maintain a small demand for soyabean. In the early 1980s improved soyabean varieties became available, but were not adopted, presumably because of the limited demand.

Data on production and exports of soyabean reflect the decline in the market of soyabean. During 1966-68 annual production of soyabean in Nigeria, according to the Groundnut Marketing Board (Ekpe, 1983), was over 15,000 t per year. Production decreased to 9,000 t in the early 1970s and under 2000 t in the 1972-79 period. Export data from the United States Department of Agriculture (USDA, 1989) show that annual average exports of soyabean just before the civil war (1964-65) were 13,500 t. During the years after the war through 1976 average annual exports amounted to 3,500t.

Exports ceased in 1977.

Empirical evidence of a recovery in soyabean production

Three field surveys were carried out in Benue State during 1989 and 1990. The first survey consisted of village level interviews with groups of farmers throughout the state. One village was randomly selected per 65,000 people in each administrative unit known as Local Government Areas (LGA) giving a total of 55 sample villages. In the second survey forty seven soyabean producers were randomly selected from the major soyabean producing area which consisted of the main market centre, Gboko, in the Tiv part of the state, and six neighbouring LGAs. In the third survey, a total of seventy soyabean producers were interviewed from randomly selected villages in the Tiv area.

Field data showed that soyabean was widely cultivated in Benue State in 1989 and was a major cash crop in the Tiv area.It also confirmed that soyabean production declined to minimal levels during the 1970s. In 1989, soyabean was cultivated in 75% of the 55 randomly selected villages (Table 1). Cultivation was more widespread (96% of villages) in the Tiv area (eastern part of the state), than in the non-Tiv area where soyabean was a new crop, adopted since 1986 and cultivated in 1989 in 52% of the villages. In each of the sample villages farmers were asked to estimate the number of soyabean growers. In two LGAs in eastern Benue State virtually all farmers were reported to be growing soyabean. In other LGAs in the east 25 to 50% of farmers were reported to be cultivating soyabean. In the non-Tiv areas, adoption was far lower, and nowhere more than 25%. Adoption levels were comparable between male and female farmers (Fig.1).

Soyabean was reported to be a major cash crop in almost half (46%) of the Tiv villages, and had increased in importance as a cash crop since the civil war. Before the war it was not regarded as a major crop in 29% of Tiv villages. In the non-Tiv area, soyabean was not regarded as a major cash crop (Table 1). Since 1985 soyabean and rice (*Oryza sativa*) had increased in 89% of the Tiv villages. In the non-Tiv areas cassava (*Manihot esculenta*) and maize (*Zea mays*) had experienced the greatest increase. Soyabean had increased in almost half of the non-Tiv villages. During this period sesame (*Sesamum indicum*) and millet (*Pennisetum typhoides*) appeared to have experienced widespread decline. Groundnut had increased in half the Tiv villages and in 19% of the non-Tiv ones. Interviews with individual farmers confirmed the results obtained from the village group interviews. A sample of 70 farmers who were growing soyabean in 1990 were asked to estimate their production before the civil war, during the petroleum boom years and then in each year from 1982 to 1989. Only respondents who were judged to be old enough to be farming before the civil war were interviewed. In 1989 these farmers produced a total of 30.4 t, which given average yield levels in the survey of approximately 0.7t/ha, implied that the average area devoted to soyabean was 0.6 ha/farmer.In the period before the civil war (around 1965) the farmers claimed they were growing a total of 11.7 t. During the petroleum boom years (around 1975) production declined to minimal level (1.4 t). In 1987 there was a significant increase in production, which continued increasing and reached 30.4 t in 1989 (Fig.2). Production in 1989 was reported to be over six times the level in the early 1980s, and more than double the level in the pre-civil war period. These figures apply to farmers who were growing soyabean in 1990. No data were available on farmers who had grown soyabean in the past, but were no longer cultivating soyabean. If, to be conservative, it is assumed that all farmers, who were not growing soyabean in 1990, were cultivating soyabean in the past at level comparable to what current growers were then producing, an estimate of the increase in production can be obtained as follows:

Production increase in period t_n vs period t_{n-x} =(A) x (% growers$_{tn}$) where:

$$A = \frac{\text{Production of current growers}_{tn}}{\text{Production of current growers}_{tn-x}}$$

Application of this procedure to production data in Fig. 2 and soyabean adoption data in Fig.1 showed that in Gboko and Katsina Ala LGAs, where almost all farmers were growing soyabean in 1989, there had been about a six-fold increase in production since the mid-1980s and production had more than doubled when compared to the period before the civil war. In the other LGAs, in the Tiv area, where around 25-50% of farmers were growing soyabeans in 1989, production was estimated to

have increased by 60 to 400% since the early 1980s and by 65% to 130% since the period before the civil war.

Explaining the upsurge in soyabean production.

The dominant reasons given by farmers for producing soyabean were its profitability and its use for home consumption. Soyabean 's suitability for intercropping and its low labor and fertilizer requirements were also given as reasons for cultivating the crop (Table 2).

Increased profitability of soyabean

Data show that in Benue State soyabean was mainly a cash crop (Table 3). In the Tiv area farmers in 78% of the villages claimed that soyabean was grown mainly for sale. In the non-Tiv area, where soyabean had only been adopted since 1986, quantities produced were still very small. However farmers in 30% of the villages, where soyabean had been grown for at least two years, claimed that they sold all they produced. Soyabean became a profitable cash crop firstly because of a major increase in demand induced by changes in government policy, and secondly because of the adoption of improved varieties.

(i) Increased demand

Major changes in government policy occured during the mid-1980s. The Nigerian currency (Naira) was devalued from parity with the dollar to $1 = Naira 4 in 1986, and continued to depreciate reaching $1 = Naira 18.5 in 1992. Commodity marketing boards were abolished and agricultural prices deregulated. The import of major agricultural commodities such as wheat, maize, rice, and edible vegetable oils and feedcake were banned between 1985 and 1987. These changes stimulated the domestic oil/feedcake industry and therefore the demand for all oil producing commodities. Demand for soyabean increased more than for other crops because production of the traditional sources of oil (groundnut and oil palm) remained stagnant. Groundnut was suffering from severe disease problems, and oil palm, being a tree crop, was less price elastic than arable crops. Soyabean production however responded rapidly to the increased demand and the processing industry started substituting soyabean for groundnut in oil/feedcake production. Only one company, with a capacity of about 500 t, produced soyabean oil/feedcake prior to the devaluation of the currency. In 1989 there were 6 soyabean oil/feedcake companies with a capacity of over 17,000 t (Ogundipe *et al*, 1990). Data on soyabean imports indicated that the bulk of the increased demand from soyabean processers was met from local production. Soyabean imports were negligible in 1986-1988, but increased to 15,000 t in 1989 (USDA, 1989). Even at the level of 15,000 t imports were only 12% of the soyabean capacity of industrial users. Industries used locally produced soyabean because its price was competitive with imports. The price of local soyabean in 1989 (equivalent to US$277/t) was competitive for domestic use as the 1987-1990 average world price for soyabean (fob ex-Rotterdam) was US$258/t (Global Stats Ltd, 1990). Since then the Naira had depreciated by another 95%, thus further increasing the competitivesness of locally produced soyabean.

Around the mid-1980s government and non-government organizations started promoting soyabean consumption for its nutritional value. This stimulated the incorporation of soyabean into the local diet. Evidence from an urban market survey in Ibadan, South-West Nigeria showed that between 1987 and 1990 the number of markets selling soyabean had increased from 2 to 19 and the number of soyabean retailers in these markets had increased from 4 to 419 (Ogundipe and Osho, forthcoming). In addition, food processing companies started incorporating soyabean into their products. These uses were however minor compared to oil/feedcake production which accounted for 95% of the total capacity for industrial use of soyabean. Most of these processing industries were started up after the devaluation of the currency in 1986 (Ogundipe et. al, 1990).

A severe drought in 1983/84 created a shortage of locust bean which, being a tree crop, was slow to recover from the drought. This stimulated the substitution of soyabean for locust bean in *daddawa* production. All these factors led to a sharp increase in soyabean prices. The average price of soyabean in the post-devaluation period (1986-1989) was 91% higher in real terms than in the five years preceding devaluation (1981-85), (Table 4). This price increase was significantly greater than for the other crops with which soyabean competed in the farming system. Survey data showed that in the Tiv area soyabean competed

with groundnut and rice, the two other subsidiary cash crops. Price data showed that at the beginning of the decade groundnut and rice prices were more than double the price of soyabean. Towards the end of the decade they were roughly comparable (Table 4).

The above discussion showed that increased market demand for locally produced soyabean was the major factor leading to the expansion of the crop, and that the critical factor leading to this increased demand was the development of a domestic oil/feedcake processing industry. This implies that in the case of non-staple crops which are not part of the traditional diet, the existence of variable industrial uses may be a pre-requisite for their adoption as cash crops. The Indian experience with soyabean illustrates the same point (Singh, 1987). Increased demand led to increases in the private profitability of soyabean. This however need not be consistent with social efficiency. While currency devaluation undoubtedly stimulated domestic soyabean processing, the ban on edible oil imports may also have been a major incentive. The social profitability of soyabean production and processing should be investigated before attempts are made to introduce it into other farming systems in the region.

(ii) Adoption of improved varieties

In the early 1940s, when soyabean was introduced to the Tiv, the only variety available (Malayan) was low yielding, late maturing and highly susceptible to bacterial pustule. Since then the International Institute of Tropical Agriculture in collaboration with Nigerian agricultural research and extension programs, notably the Institute for Agricutural Research in Samaru, the National Cereals Research Institute in Baddegi and the Institute for Agricultural Research and Training in Ibadan has made a number of improved soyabean varieties available to farmers. A major technological breakthrough was achieved in the early 1980s when the characteristic of 'promiscuous nodulation' was transferred from Malayan to high yielding soyabean varieties. Prior to this, high yielding soyabean had failed to nodulate with African *rhizobia*. As a result they could not produce high yields in African without rhizobia innoculation, a treatment that was too expensive and complex for African small-scale farmers. Other desirable charactersistics introduced by varietal improvement included resistance to shattering, seed longevity which made it possible for farmers to store their own seed until the next harvest, and early maturity which increased the flexibility of planting dates and enabled farmers to avoid shattering by harvesting their crop before the arrival of the seasonal dry winds from the Sahara (Dashiell *et al.*, 1987). These technological advances made improved soyabean adoptable under the constraints faced by small-scale farmers in Africa. Under experimental conditions, yields of the improved varieties were 3 to 3.6 times higher than the yield of Malayan (Dashiell, Oyekan and Akem, unpublished data). On farmers' fields, the yield advantage of improved varieties would undoubtedly be lower, however they should still be substantial.

Improved varieties appear to have been widely adopted. A small survey of twenty randomly selected producers in the Tiv area found that all but four farmers were growing improved varieties either alone or in mixtures with Malayan. These results are comparable to another survey of 307 randomly selected fields in 1990, which showed that improved varieties (alone or in mixtures with Malayan) were grown in 89% of fields (unpublished field survey by C.N. Akem, personal communication, 1990). Adoption of improved varieties, with their yield advantage, therefore also contributed to the increased profitability of soyabean production.

Comsumption of soyabean by farm families

In the village group interviews, farmers were asked how soyabean was commonly used in the village. In the Tiv area, at least some of the soyabean was used for home consumption in 96% of the villages. In the non-Tiv area where soyabean was a relatively new crop, soyabean was consumed in 26% of the villages. Farmers in all the Tiv villages which consumed soyabean used it as a substitute for locust bean in the preparation of *daddawa*. Soyabean was also widely used (81-96% of the villages) as a partial substitute for cowpea *Vigna unguiculata* (L.). Substitution of soyabean for locust bean was less common in the non-Tiv villages. Soyabean was however widely substituted for cowpea in local foods.

The substitution of soyabean for cowpea and locust bean has considerable potential for improving the nutritional content of rural

diets at a lower cost. The substitution of 33 - 50% soyabean in local cowpea products would increase the protein content of these foods by 30-50%, since the protein content of soyabean (40%) is about double that of cowpea. In addition, soyabean is more economical than cowpea. With cowpea prices being about 2.4 times the price of soyabean (BSADP, 1989), the substitution of soyabean would reduce the cost of these local foods by 20-30. The protein content of locust bean is about 18% higher than soyabean (Odunfa, 1985). However about two times as much soyabean daddawa is required for seasoning stews. Adequate data on the economics of substituting soyabean for locust bean daddawa production are not available. It is known however that soyabean is cheaper than locust bean and the cooking time of soyabean in *daddawa* production is about one-fourth that of locust bean (Waters-Bayer, 1989).

Compatibility with farmers' resources

Benue State is an area that is relatively abundant in land, the population density being moderate by the standards of West Africa. Short fallow periods still exist. Labour and material inputs are the two resources that are usually scarce in land abundant regions. This is consistent with the findings of the survey in Benue State. Hired labour was found to be uncommon in the area and farming was done almost entirely with family or communial labour. Use of material inputs, such as fertilizer was minimal. In this situation farmers would be interested in expanding crops which economize on labour and material inputs and high returns to these scarce resources. Farmers regarded soyabean as being economical in the use of labour and fertilizer relative to other crops (Table 2). Survey data showed that average labour use/ha for soyabean was 7% lower than for groundnut and significantly lower (19%) than for rice. The data however showed that the average return to a day of labour was significantly lower for soyabean than labour intensive because the timing of its labour requirements was convenient relative to the schedule for other crops. While groundnut planting conflicted with the planting of yam, and rice harvesting conflicted with the yam harvest, soyabean planting occured conveniently when the peak period of groundnut and yam planting was over. Likewise the soyabean harvest took place before the peak period of yam harvest (Figure 3). Soyabean planting and harvesting conflicted with rice planting and harvesting, but this would probably have been regarded as less serious than conflicts with yam, the dominant crop. It appears therefore that the more favorable distribution of labour requirements for soyabean was a major farm level factor in the expansion of soyabean.

Legumes such as soyabean and groundnut may have advantages relative to highly fertilizer responsive crops such as rice and maize in many parts of West Africa where fertilizer availability is a major problem. Only 10% of sample farmers fertilized soyabean in 1989. 27% commented that one of soyabean's advantages was its ability to perform well without fertilizer (Table 2).

CONCLUSION

This paper demonstrated the importance of government policy considerations in farming systems research. Farming systems practitioners in West Africa had long been aware of the multiple contributions soyabean could make to the welfare of farming families in the region. Soyabean production, home consumption and use by local industries however remained minimal in the region as a whole. Repeated attempts to introduce the crop into new areas met with very limited adoption because farmers were unable to dispose of the crop. In the last few years a major expansion in soyabean production occurred spontaneously in an area of Benue State, Nigeria, which had a story of soyabean production during colonial times. The analysis documented this expansion and demonstrated that the major cause of this expansion was the development of a domestic industrial processing industry, which occurred as a result of changes in government policies. The implication is that attempts to introduce technologies when the policy environment is unfavorable are unlikely to succeed. Analysis of the impact of policy measures on farm level incentives should therefore be an integral part of farming systems research. The paper also pointed out that the expansion of soyabean was in response to an increase in the private profitability of soyabean production. This may not be consistent with social efficiency, particularly in view of the existence of import bans which may be artificially increasing incentives for the domestic processing industry. Social profitability considerations, and not adoption alone, should be

taken into account before farming systems practitioners promote technologies at the farm level.

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Table1. Expansion of soybean: village group interviews Benue State, Nigeria: 1989.

	Tiv Area	Non-Tiv Area
Number of Villages	28	27
1989	% Villages	
Soybean produced	96	52
Soybean a major cash crop	46	0
Before Civil War (~ 1965) Villages Growing Soybean as a Major Cash Crop	29	0
Changes Since 1985		
Increasing Crops:		
Soybean	89	48
Rice	89	52
Maize	39	67
Groundnut	50	19
Cassava	61	78
Decreasing Crops:		
Sesame	47	89
Millet	53	68

Table 2. Reasons for producing soybean: Benue State, Nigeria: 1989, village group interviews, and individual interviews.

	Tiv Area	Non-Tiv Area	Tiv Area
No. of villages/farmers	27	14	47
Reasons	% Villages		% farmers
Financial return	78	50	92
Personal consumption/ nutritional qualities	96	57	66
Compatible for inter-cropping.	85	36	15
Improves soil fertility and/or does well without fertilizers.	52	0	27
Requires less labour than some other crops.	13	7	52

Table 3. Disposal of soybean: village group interviews, Benue State, Nigeria, 1989.

	Tiv Area	Non-Tiv Area[1/]
No. of villages	27	10
	% villages	
Home consumption only	18	10
Mostly home consumption	0	20
Home consumption and sale	0	10
Mostly for sale	78	30
All for sale	4	30

1/ Villages growing soybean for at least 2 years.

Table 4 Retail prices: soybean, groundnut, rice (1981-1989)[1/]

	NOMINAL PRICE			REAL PRICE[2/]			PRICE RATIO	
Year	S'bean	G'nut	Rice	S'bean	Gnut	Rice	Gnut/Soy	Rice/Soy
				Naira/ton[3/]				
1981	155	305	551	63	124	225	2.0	3.6
1982	175	382	463	66	145	175	2.2	2.6
1983	230	598	524	70	183	160	2.6	2.3
1984	2650	1535	1244	582	337	273	0.6	0.5
1985	800	1423	1479	166	295	307	1.8	1.8
1986	1100	1477	1323	218	292	262	1.3	1.2
1987	1432	1235	1259	256	221	225	0.9	0.9
1988	1732	1654	1862	213	203	229	1.0	1.1
1989	2076	2913	3045	760	1067	1115	1.4	1.5

1/ Source: Soybean prices from Benue State: Oyekan (1987) for 1981-87 data, BSADP (1989) for 1988-89. Groundnut and rice prices from Kaduna State: George and Kambai, undated.
Price ratios in any particular year should be treated with caution, but trends in price ratios over time remain valid.

2/ Deflated by Rural Consumer Price Index; Source: Federal Office of Statistics, Nigeria.

3/ US $1 = ₦0.61 in 1981.
=₦7.49 in 1989.

Table 5. Labor use and returns to labor: interviews with 47 soybean producers, Eastern Benue State, Nigeria, 1989.

	Soybean	Groundnut	Rice
Number of observations	40	22	5
Average yield (t/ha)	0.76	1.52	1.33
Producer price (N/t)	2005	1183	2539
Gross revenue (N/ha)	1524	1798	3377
Cost of material inputs (N/ha)	82	41	187
Labor Use (Hours/ha)[1/]	860	873	1036
Return to labor (N/hour)[2/]	1.68	2.01	3.08

[1/] t = -0.2 (df = 60). Prob >t =0.84: soybean vs groundnut
t = -1.85 (df = 43). Prob >t =0.07: soybean vs rice

[2/] t = -2.18 (df = 60). Prob >t =0.04: soybean vs groundnut
t = - 3.59 (df = 43). Prob >t =0.001: soybean vs rice

Figure 1. Benue State, Nigeria: Soybean producers per Local Government Area, field survey 1989. M and F refer to % male and female farmers growing soybean in 1989.

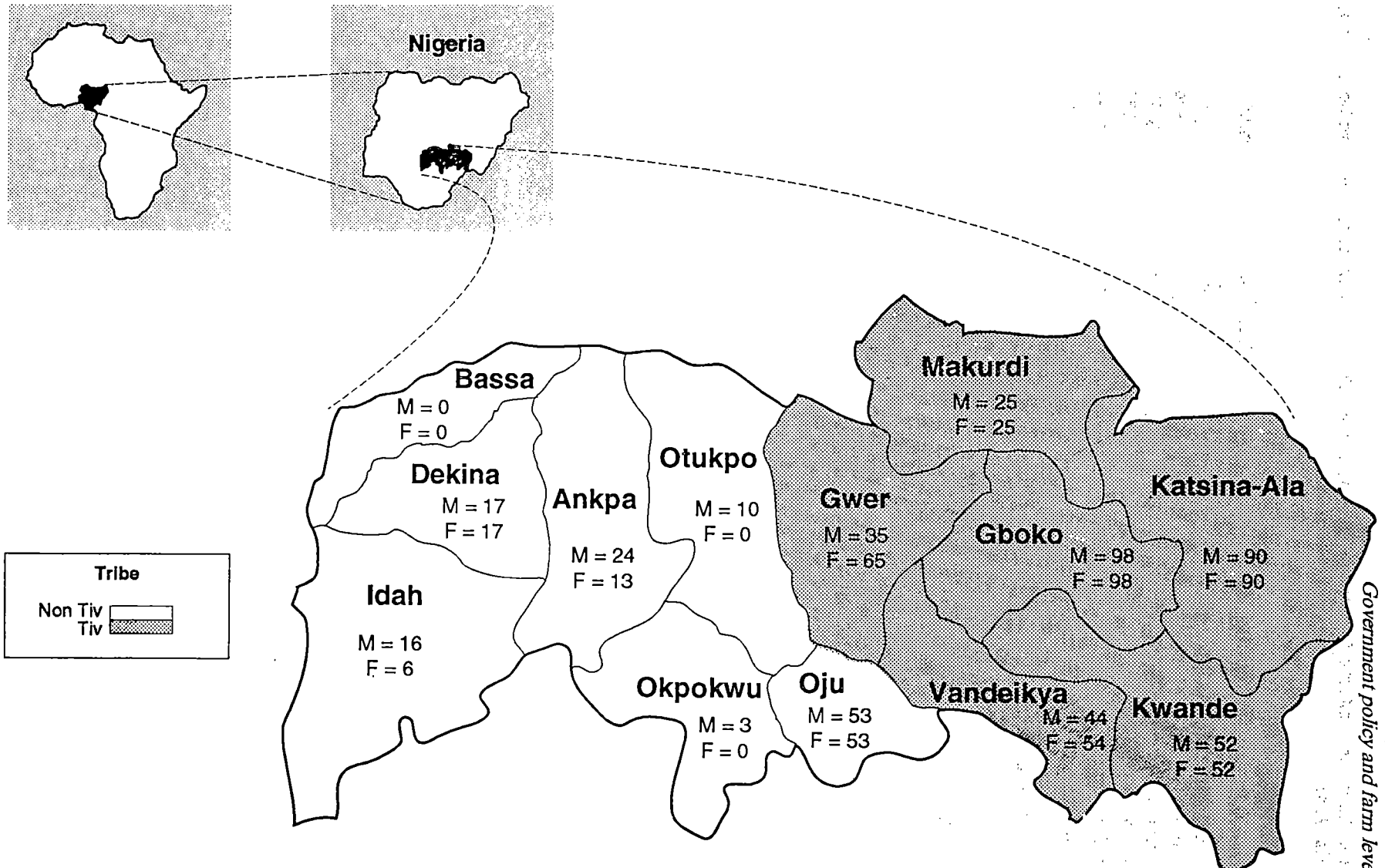


Figure 2. Soybean production: interviews with 70 producers in Eastern Benue State, Nigeria, 1990.

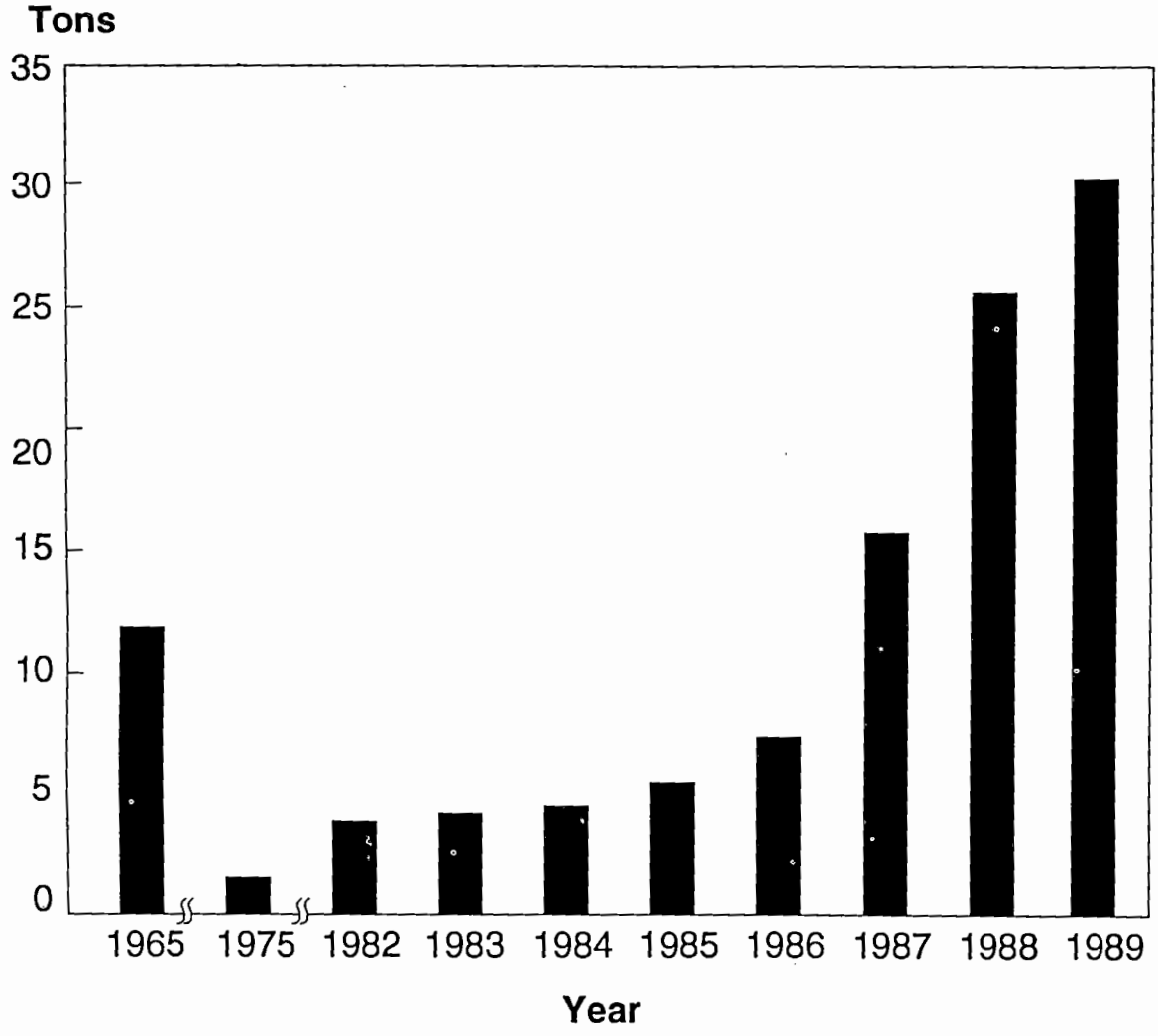
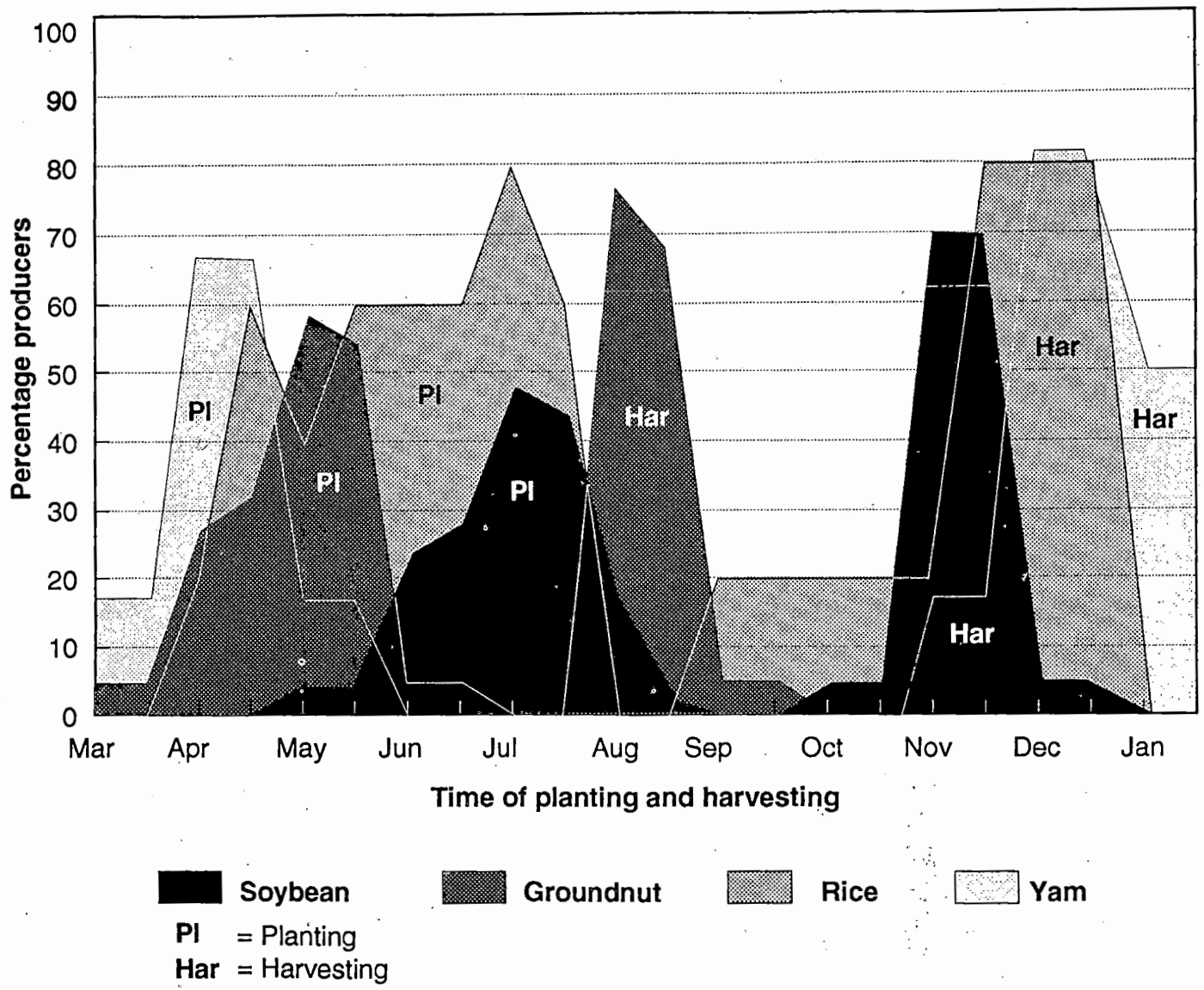


Figure 3. Time of planting and harvesting soybean,groundnut, rice and yam: Eastern Benue State Nigeria, interviews with 47 soybean producers 1989.



INDIGENOUS KNOWLEDGE SYSTEMS AND FARMING SYSTEMS DEVELOPMENT: SOME BASIC ISSUES

S. TUNJI TITILOLA[1]

SUMMARY

This paper examines the importance of local, traditional or indigenous agricultural systems and knowledge of farmers in less developed countries. The paper expresses the opinion that such knowledge systems have not been given adequate attention in the formulation of agricultural research. It should, however, be noted that Farming Systems Research and Extension (FSRE) programmes have, in the past decade attempted to provide new paradigms into agricultural policy formulation that seek to incorporate farmers perspective into agricultural research and extension. The paper concludes by noting that though not all modern technologies will be useful and readily adaptable, indigenous knowledge systems will help discern useful practices.

Keywords: Indigenous knowledge, farming system research & extension, agricultural research and extension.

RESUME

Cet article étudie l'importance des systemes agricoles locaux, traditionnels ou endogènes et du savoir des cultivateurs des pays en voie de développement. Cette étude soutient qu'on ne prête pas assez d'attention à ces systèmes de connaissance dans la formulation de la recherche agricole. Il est nécessaire de noter toutefois que les programmes de recherche sur les systèmes de production et de vulgarisation au cours des dix dernieres années ont fait des efforts pour introduire des nouveaux paradigmes dans la formulation de la politique agricole, cherchant ainsi à incorporer une perspective paysanne à la recherche agricole et à la vulgarisation. L'article conclut en remarquant que malgré le fait que les technologies modernes ne soient pas toutes utiles et facilement accesibles, les systèmes de connaissance endogènes aideront à discerner les usages utiles.

Mots clés: Connaissance endogène, recherche sur les systèmes de production et de vulgarisation, recherche agricole et vulgarisation.

INTRODUCTION

After almost half a century of development activities in less developed countries (LDC's), those countries are still finding solutions to pressing problems such as economic stagnation, declining agricultural production and associated problems of environmental degradation. Part of the reasons for the failure of development efforts to fully realise results include inappropriate technologies and research focus, as well as lack of appropriate management.

Technologies appropriate to the factor endownments of most LDCs are not yet in place and many agricultural technologies transfered to LDC's proved to be ineffective.

Efforts to develop technologies for LDCs were meeting with disappointments largely because the environments and socio-economic systems of the region were poorly understood. Ruddle and Chesterfield (quoted in Christoffel deb Biggelaar, 1989:4) noted that: "no new approach to rural development will succeed unless it clearly manifests a thorough understanding of traditional and human ecosystems which it intends to change and the clients' values, aspirations, mores and the perceptions of the bio-physical environment, particularly as the latter pertains to renewable natural resources

Recent trends in agricultural and rural development literature especially among those who have had previous work experience in LDC's, are in favour of utilizing local and indigenous knowledge (IK) in combination with other knowledge systems in the solution of less developed countries' agricultural problems (Richards, 1985; Altieri, 1988). For instance, a Panel Report of the Board of Science and Technology for International Development, United States International Research Council (1992) admitted that the desirability and sustainability of the standard development paradigm are being challenged by growing numbers of people in the

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developed and the developing nations and within the international development community". Local knowledge systems, in several cases, are considered quite complex but well adapted to local environments and social conditions. A growing number of publications are now appearing about IK systems and the farming systems based upon them (Brokensha et. al, 1980; Biggs and Clay, 1981; Rhoade, 1984; Richards, 1985; Marten, 1986; Warren et al, 1989) which reveal their complexity and sophistication in dealing with environmental hazards. Vermeer (1983) discussed the importance of smallholder agriculture and their knowledge systems and noted rudimentary understanding of those systems. Yet these agricultural systems have provided and will continue to bear the primary responsibility of providing essential foodstuffs in the developing world for many years to come.

This paper examines the importance of local, traditional or indigenous agricultural systems and knowledge of LDC farmers. Specifically, the paper discusses: the concept of local, traditional or indigenous knowledge systems and farming systems develpment; available evidence of the relevance and importance of such knowledge systems, and implications and limitations of such knowledge systems for the future of agricultural development in LDC's.

The Concept of Indigenous Knowledge Systems

Indigenous knowledge is an important aspect of the culture and technology of a society. Warren and Cashman (1988) characterised such knowledge as the sum of experiences and knowledge for a given group that forms the basis for decision making with regard to familiar and unfamiliar problems and challenges. Similarly, Altieri (1988) characterised such knowledge as accumulated knowledge, skills and technology of the local people derived from systems of production and consumption with the following key components: organized technical knowledge, social institutions, decision making, and management of diverse natural resources, technology, and skilled labour. Some IKS are responding creatively to challenges through local adaptation, experimentation, and innovation under diverse, heterogenous conditions. Successful adaptations are preserved and passed on from one generation to another through oral and/or experimental means. Thus indigenous knowledge is dynamic. Contrary to what the term may seem to imply or connote, "traditional" or local knowledge is not necessarily simple nor does it occur in a vacuum. It is ever changing, and very often borrows selectively from outsiders (Niamir, 1990). Agricultural scientists and policy makers must, therefore, begin to recognize such systems and knowledge for their inherent value and not as obstacles to be eradicated and replace entirely by other systems but as a basis for introducing new and improved farming systems designed to use inputs efficiently and achieve sustainability. An understanding of IKS, therefore, reflects a greater need and willingness to consider particular problems and potentials at the local level (Niamir, 1990). The socio-economic appropriateness of IK in agriculture and years of experience of farmers have led to successful techniques, such as mixed cropping patterns, water management techniques, seed selections, food processing and storage techniques and other adaptations to the environment.

Kotschi *et al* (1989) further described IKS as low external input systems making use of locally available energy and material and practical environmental knowledge. Such techniques and strategies can be regarded as the result of deliberate efforts to improve and/or protect the environment. IKS share the following characteristics of low resource agriculture:

- they strive to reduce risk, even if this means obtaining less than maximum yield;
- they depend on local technology;
- they involve low cash cost, but relatively high labour cost; and
- they are adapted to local cultures and environments although social and ecological systems are showing increasing strains under growing pressures (OTA 1988:).

IKS is important because it optimally utilizes available resources, explores and exploits existing diversities, takes into account the instability of the environment, and provides livelihood whilst appreciating the need to sustain the productive resource base (Warren *et al* 1989:). In addition, IKS provides alternative methods of solving problems in cases where outside or exogenous solutions to local agriculture problems do not fit the local systems. Also, due to knowledge diversity, IK can become vital resource for agricultural development.

Improving farming systems in LDCs requires an understanding of the existing farming systems along with an understanding of how science and technology can aid a particular system. In brief, therefore, what is needed is a programme capable of generating its own unique, appropriate technology in addition to adapting, where feasible, from the existing stocks of international technologies. While most traditional production systems are well adapted to the environment, many of them are under stress due to rapid population growth and environmental degradation. It is therefore essential to integrate traditional and new techniques in agricultural research. The traditional approaches can act as a starting point to develop appropriate new technologies (OTA 1988:).

Evidence And Relevance Of IKS

The use of local knowledge in development can be traced to the early works of anthropologists and geographers (Barlett, 1990). In recent times, however, ecologists (Altieri, 1988) and economists (Norgaard, 1984), because of their concerns for the environmental deterioration and sustainability issues, have given renewed interest to the use of local and traditional knowledge in agricultural development. One reason for such attention is that most of the technical solutions proposed to address problems of agriculture in LDCs have not been totally successful. Such approaches have not been successful because they have not taken into consideration unique resource endowment issues such as energy availability, ecosystem fragility, skills, preferences, and knowledge base of the society (Gran, 1986). Low risk and low input preferences in decision-making were neither adequately appreciated nor integrated into the search for appropriate technologies. These factors are, in part, responsible for the poor adoption rate of the technologies that were introduced.

Earlier attention to large-scale agricultural schemes which paid little attention to factor endowments has resulted in limited success and, above all, in the neglect of traditional agriculture. Such neglect weakened the role of traditional or local agriculture in food production. Given the limited role of large-scale agriculture in food production in Nigeria and the endorsement of small-scale farmers by national governments and international organizations, traditional agriculture or its modification will continue to be of importance in the future.

Local knowledge is important for the success of agricultural development activities. Solutions offered by development project experts often fail because such solutions do not fit in well with the local knowledge systems. Indigenous knowledge is capable of providing alternative methods of viewing and solving agricultural problems. The success of development efforts often depends on local participation. Familiarity with indigenous knowledge can therefore help experts to understand and communicate with local people thereby enhancing the possibilities for participatory approaches to development and sustainability of these efforts. Other reasons advanced by Kotschi *et al.*(1989) include the following:

- the present form of resource use has sustained people in resource-poor and fragile environments and must be preserved until proven superior forms of resource use have been developed;
- local farming knowledge can supply missing ecological links which could help scientists to develop alternative farming systems.
- local farming practices and environmental knowledge could offer a starting point for developing farming methods which may increase the productivity and sustainability of local resources.

Another reason of the usefulness, value, and relevance of local knowledge is its relationship to the concept of sustainability and conservation of biodiversity.

Sustainable development is now a major concern of agricultural researchers and policy makers in both developed and developing countries.

Indigenous Knowledge and Farming Systems Development

In 1987, the World Commission on Environmental and Development drew attention to the problems and challenges facing the world agriculture, if present and future need are to be met, and to the need for a new approach to agricultural development. It also noted that: "the agricultural systems that have been built over the past few decades have contributed greatly to the alleviation of hunger and the raising of living standard. They have served their purposes of smaller, more fragemented world. New realities revealed their inherent contradictions. These realities require agricultural systems which focus as much

attention on people as they do on technology, as much on resources as on production as much on the long-term as on the short-term. Only such systems can meet the challenge of the future".

Small-scale farmers in less-developed countries (LDCs) have been affected little by worldwide technological advances. Many recommendations for farming improvements have not been adopted because small-scale farmers find them inappropriate to their needs and resources.

Although substantial investments of time and money have been made in the last two decades by national and international research organizations, their impact has not been commensurate and the pay off, if any, is still to be realized. Research communities are aware of technological gaps existing between small-scale farmers in LDCs and what is technically feasible. Earlier attempts to bridge this gap brought farmers and researchers together in dalogue through what is popularly called On-Farm Research or Farming Systems Research and Extension (FSRE). FSRE is a response to difficulties encountered in the extension of research results developed on experimental research stations. As good as the concept is, it has been criticized for not going far enough in its interaction with and use of farmers' knowledge (Christoffel deb Biggelaar, 1992:). Farmers' knowledge is considered a critical input in an attempt to solve the technological problems of small-scale farmers. In addition, the process of technology generation has not made farmers active participants in the planning, execution, and evaluation of research. Farmers participate in on-farm research either with a nominal presence or, at best, as physical participants in complementing production operations for on-farm trials (Ashby, 1988). In the past decade, Farming Systems Research and Extension (FSRE) has provided new and additional paradigms that seek to incorporate farmers' perspectives into national agricultural research and extension. Despite these flaws, FSRE programmes provide an excellent opportunity to incorporate indigenous, on-farm technology into the analysis of problems and the assessment of potentials, together with the design and testing of possible solutions. Experience with such programmes has pointed out the values inherent in farmers' knowledge and has made scientists realise the importance of incorporating such knowledge into agricultural development programmes.

Implications And Conclusion

A review of the literature dealing with agricultural development in LDCs indicates that only a token attention is accorded traditional or local agriculture practices and the knowledge inherent in them. This was a key weakness of many technology design efforts. However, farmers practising these systems and utilizing such knowledge are recognized as significant in the rural economy. This at best seems contradictory. Recognition of the value of traditional knowledge for agricultural and rural development does not imply a rejection of modern technology, nor should support for the use of local knowledge in agriculture be construed to mean an uncritical return to traditional technologies if better alternatives are available (Titilola, 1990).

The lastest attempt at moving closer to addressing farmers' problems is the introduction of Farming Systems Research (FSR) approach to research and extension in many developing countries. It needs to be encouraged and strengthened because it can improve communications between farmers and researchers as well as assist with problem indentification and resolution. However, the best and most adaptable features of the traditional system should, where possible, be the foundation of farming development system. Despite several problems that need to be resolved in order to improve the effectiveness of FSRE, it is a valuable working framework on which, with proper modifications, farmers' participatory models can be built. Certain modifications to FSR may be desirable to permit farmers' participation throughout the Research and Development (R & D) phases. According to Kotschi *et al* (1988) the basic component of FSRE are:

- investigation by an interdisciplinary team of scientists of the existing farming system,
- identification of constraints to higher production,
- design of innovation to alleviate constraints,
- on-farm testing of the innovation, and
- extention of successful innovation, to a wider group.

Currently, not all modern technologies will be useful and readily adaptable. Nevertheless, knowledge of indigenous technology will help to discern useful practices for selection. A creative combination of indigenous and external

research strategies tailored to the specific nature and socio-economic diversity of LDCs must be pursued. Science and technology have been accepted as a source of improvement in developing and developed countries. People in developing countries benefit from the integration of appropriate modern methods and technologies into traditional ones without endangering the local environment and societies in the process. Therefore, an adequate knowledge and understanding of the existence, value and importance of such knowledge system is a significant component essential to the success of these new efforts and, in addition, may provide valuable new insights for solving many of the environmental and resource problems.

Effective incorporation of such knowledge systems into the development process requires the following essential future research work (Niamir, 1990):

- developing a methodology for collecting and analyzing information on local knowledge and management systems;
- looking at some potential applications of such knowledge systems in agriculture and natural resource management;
- pre-requisites for effective utilization of such knowledge including policies, institutions building; and
- identifying gaps in our understanding of the knowledge system in developing countries.

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FARMER PARTICIPATION IN TECHNOLOGY TESTING: A CASE OF AGRONOMIC EVALUATION OF COWPEA GENOTYPES IN THE NIGERIAN NORTHERN GUINEA SAVANNA

K.A. ELEMO[1]

SUMMARY

Farmer-managed trials were carried out to evaluate the performance and acceptability of elite cowpea *(Vigna unguiculata* (L.) Walp) cultivars with and without insecticides. Cultivars IT84E-1-108, IT84S-2246-4, IT84E-124, IT81D-994, IT82D-699 were tested with check variety Sampea 7 and farmers' local varieties in mixture with sorghum/millet and relay with millet. Chemical insect pest control of cowpea significantly increased grain yields irrespective of cultivar and cropping system. None of the elite cultivars outyielded the local varieties with or without insecticide. Local varieties of cowpea without insecticides at worst yielded as high as insecticide sprayed IT84E-1-108 and IT84E-124. Sampea 7 produced highest grain yield comparable to the local varieties when sprayed with insecticides, but gave significantly lower yields than the local varieties without insecticide. The farmers ranked Sampea 7 highest in acceptability because of the grain quality.

Keywords: Cowpea, farmer-managed, millet relay crop, sorghum/millet, mixture, farmer variety, elite cultivars, insect pest control.

RESUME

Des essais ont été conduites auprès des paysans en vue d'évaluer la performance et l'acceptabilité des certains cultivars de niébé (*vigna unguiculata* (L.) walp) avec ou sans usage d'insecticides. Les cultivars IT84E-1-108, IT84S-2246-4, IT84E-124, IT81D-994 et IT82D-699 ont été testés en association avec le sorgho/mil avec pour variétés contrôle le Sampea 7 et certaines variétés locales. La lutte chimique contre les insectes parasites du niébé augmente significativement les rendements et ceci indépendamment du cultivar ou du système de culture considéré. Toutefois aucun des cultivars d'élite n'a donné un rendement supérieur à celui des variétés locales avec ou sans usage d'insecticides. Dans le pire des cas, les variétés locales cultivées sans usage d'insecticides ont donné un rendement aussi élevé que celui des cultivars IT84E-1-108 et IT84E-124 traités à l'insecticide. Le Sampea 7 lorsqu'il est traité donne un rendement comparable à celui des variétés locales avec usage d'insecticide; toutefois son rendement est significativement plus bas que celui des variétés locales lorsqu'il n'est pas traité avec un insecticide. Du point de vue de l'acceptabilité, les paysans classent au premier rang le sampea 7 à cause de la qualité de son grain.

Mots clés: Niébé, sorgho, mil, culture de relais, association culturale variété locale, cultivars d'élite, lutte contre les insectes.

INTRODUCTION

Cowpea *(Vigna unguiculata* (L.) Walp) production in Nigeria which accounts for about 37% of worldwide output (Singh and Bachie, 1985) is mostly produced in the savanna agroecological zones. Although the average grain yield is low at about 150-200 kg/ha (Hays and Raheja, 1979), recent advances in production have raised yield levels to 1,500-2,000 kg/ha under sole cropping technology with optimum insecticide protection. Nevertheless, this is yet to extend to the fields of small scale farmers who are the primary producers. These farmers operate farming systems that consider cowpea as a minor crop grown in multiple cropping with the principal cereals staple food crops.

Until recently, agricultural research approach never consider the small-scale farmers as client of research. Technologies were developed by on-station and passed on to extension for communication to farmers. The results were lack of adoption of such technologies because of improper consideration of the human and technical environments in which the farmers operate. Williams (1972) reported that farmers who tried new varieties of rice and cotton reverted back to their traditional varieties as the new varieties failed to produce better yields than the local cultivars under the traditional system of management. In the northern Guinea Savanna ecology, most peasant farmers first cultivate pearl millet (*Pennisetum americanum* (L.) Leeke) in mixture with sorghum (*sorghum bicolor* (L.) Moench) or alone after which

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cowpea is introduced just prior to millet harvest.

This paper presents on-farm study aimed at evaluating the performance and acceptability of elite cowpea cultivars, with or without insect pest control, in the traditional cropping systems.

MATERIALS AND METHODS

Experiments were conducted on-farm during the 1987 and 1988 wet seasons at Bomo village located in the northern Guinea Savanna agroecological zone about two kilometres off the Institute for Agricultural Research (IAR), Samaru, Nigeria. Details of the technical and human elements of the farming systems have been discussed elsewhere (Elemo, 1988; Elemo *et. al.* 1990).

For each of the two cropping systems (sorghum/millet/cowpea and millet/cowpea), two farmers were selected based on their expressed interest and accessibility of their fields. Insecticide spray or no spray constituted a factor while cowpea genotypes constituted another which were arranged in a randomized complete block design with a farmer serving as a replicate.

Five of the elite cowpea genotypes (IT81D-994, IT84S-2246-4, IT84E-124, IT84E-1-108 and IT82D-699) were obtained from the International Institute for Tropical Agriculture at Ibadan, Nigeria, while another standard recommended check variety (Sampea 7) was obtained from IAR. With the exception of IT81D-994, which is weakly photoperiod-sensitive, all the test cultivars were semi-errect, photoperiod-insensitive types. Although each of the farmers cultivated a local cowpea variety (farmer's variety), the farmers who operated the millet/cowpea system in 1987 chose to cultivate two local varieties of cowpea. All the farmers' varieties were spreading and strongly photoperiod-sensitive with rough white seed testa. Aside from supplying the farmers with the test cultivars, insecticide application was carried out by the researcher. For the sprayed treatments, 100 kg a.i./ha of cypermethrin (Cymbush 10EC) mixed with 500 g a.i./ha of dimethoate (Perfekthion 40EC) in 100 litres of water was applied four times with knaspsack sprayer at 10-day intervals starting from a week to the commencement of flowering of each cultivar. No fungicide was sprayed. All crop management practices were carried out by the farmers who used the *gicci* system (Baker, 1980) quite common in the area. In the system involving sorghum, millet was spaced in alternate stands with sorghum along ridges at about 0.5m between stands at 3-5 plants/stand. However, there was some other variations in the distance between the millet and sorghum stands. In the millet/cowpea system, cereal was planted at 0.5m stand spacing along ridges. Cowpea was planted on the ridge at one side of millet stand for the local varieties while planting was on both sides of millet stand for the improved varieties at 2-3 seeds per hole without thinning. The farmers used only compound fertilizer (15-15-15 of NPK) but the quantity applied depended on availability. An estimated average rate of 30 Kg N, 30 kg $P_2 0_5$ and 30 kg $K_2 0$/ha were applied. This was mainly to the cereal crop at 2-3 weeks after emergence. The farmers always kept their field weed-free.

Assessment of farmer's preference for cowpea cultivar was carried out at planting and harvest. Seeds of the cowpea cultivars were displayed for rating by each farmer separately. A cultivar most preferred was ranked one while the least was ranked seventh or eighth depending on the total number of cultivars. The figures were then averaged across time of rating and farmers to determine the overall order of preference. Data were collected on pod maturity, hundred-grain weight and grain yield and analysed using the analysis of variance technique. The means were comapred using the Duncan Multiple Range Test or the Least Significant Difference.

RESULTS

The grain yield of cowpea in mixture with sorghum/millet and in relay crop with millet in 1987 and 1988 are presented in Table 1. There was significant variations in grain yield between farmers in 1987 but not in 1988. The main effects of genotype and chemical insect pest control were significant as well as their interaction; an exception being the mixture with sorghum/millet in 1987 for which the interaction was not significant.

In 1987, protection of cowpea in relay with millet increased grain yield of all cultivars with the exception of IT84S-2246-4 which gave similar yield without chemical control (Table 2). Farmer's variety 2 outyielded all elite cultivars without pest control. Grain yield obtained was even significantly higher with the farmer's variety than with protected IT84E-1-108, IT84S-2246 and IT84E-124.

When protected, Farmer's variety 2 was as high yielding as Sampea 7. In relay system with millet in 1988, grain yield of protected farmer variety 2 was statistically at par with Sampea 7 as well as IT82D-699 which were superior to other cultivars. However, without chemical pest control, the grain yield of Farmer's variety 2 was superior to only those of IT84E-1-108 and IT84E-124. Even when protected, these cultivars did not outyield the unprotected Farmer's variety 2. In the sorghum/millet system in 1988, the farmer's variety significantly outyielded all the elite cultivars without chemical pest control. Grain yields among the elite cultivars were so low that the differences were not significant. The unprotected farmer's variety was not significantly different in grain yield as compared to the protected elite cultivars.

Pod maturity did not significantly vary between farmers (Table 3). Nevertheless, the main effects of genotype was significant. Pods of IT84E-1-108, IT84S-2246-4, IT84E 124 were significantly early. Those of IT81D-994, IT82D-699 and Sampea 7 were medium in maturity while the farmer's varieties were late. Inspite of the lateness, appreciable differences exist between pod maturity of the local farmer's varieties. With the exception of the system with sorghum/millet in 1987, the main effect of pest control was also significant. Lack of chemical pest control generally delayed pod maturity. Nevertheless, the interaction between genotype and pest control was significant only in 1988.

For cowpea in relay system with millet during the 1988 season, lack of pest control significantly prolonged days to pod maturity in IT84E-1-108, IT84S-2246-4, IT84E-124 and IT81D-994 (Table 4). Such difference in pod maturity was not observed in cultivars IT82D-699, Sampea 7 and the farmer's variety. In sorghum/millet system also in 1988, there was also no significant difference with or without pest control.

Hundred-grain weight of cowpea did not vary significantly between farmers (Table 5). The main effect of genotype was however significant in both systems and years. Although seeds of IT84E-1-108, IT84S-2246-4 and IT82D-699 were consistently smaller than the farmer's variety, cultivars IT81D-994 and Sampea 7 produced seeds statistically similar in size to the local variety. It was only in 1988 that lack of pest control of cowpea significantly decreased grain size and this was peculiar to the sorghum/millet system. The interaction effect of genotype and pest control was significant for the hundred-grain weight.

On the farmer's assessment of the cowpea cultivars, Sampea 7 was consistently ranked highest by farmers irrespective of system and year (Tables 6 and 7). Farmers who cultivated sorghum/millet/cowpea system ranked their local variety as second. Farmers who operated the millet/cowpea relay system, on the other hand, preferred IT81D-994 next to Sampea 7 while their local variety was ranked low. IT82D-699 received low preference in both systems inspite of the high grain yield.

DISCUSSION

The results show that chemical insect pest control of cowpea significantly increased grain yields in both relay system with millet and mixture with sorghum/millet.

Chemical insect pest control has long been identified as a crucial component of cowpea production (Raheja, 1976; Taylor and Ezedinma, 1964). Of the elite test cultivars, Shoyinka and Singh (1987) confirmed IT84E-1-108 as resistant to aphid; IT84S-2246-4 as resistant to bruchid, aphid and thrips; IT81D-994 as resistant to bruchid and IT82D-699 as resistant to thrips. None of these cultivars proved that the level of insect resistance was enough to justify non-application of insecticides. An exception was IT84S-2246-4 in relay with millet in 1987. Even then, this cultivar produced better yield with insecticides in 1988 when insect pest pressure was more on the field. As none of the cultivars is resistant to the pod-sucking bug complex, which was more prevailent in 1988 from cursory observation, the positive response to insecticide became obvious.

Farmer's variety 2 in relay with millet in 1987 demonstrated that a local cowpea variety could be as high yielding as best yielding elite cultivar (Sampea 7, IT82D-699) when sprayed with insecticides. It is very striking that Farmer's Variety 2 without pest control yielded as high as elite cultivar (IT81D-124), with insecticides. Nevertheless, the poorer performance of Farmer's Variety 1 than Farmer's Variety 2 suggests that not all local varieties are better than elite ones. Data on pod maturity indicate that the local cowpea varieties of the farmers are late maturing. This is because they pro-

duced most of their flowers and pods towards the end of the rains unlike the elite cultivars. Being indeterminate, the flowers and pods tended to escape most of the diseases and pests prevailent during the rains. This is perhaps why local varieties tended to yield higher than elite cultivars without pest control.

Grain yield of cowpea appeared to be generally higher in relay with millet than in mixture with sorghum/millet. Andrew (1972) found that the yield potential of cowpea in any mixture with sorghum is low because sorghum competes with cowpea throughout the growth period of the latter.

It is interesting to note that farmers generally ranked Sampea 7 as most preferable for both cropping systems even above their local varieties. They argued that Sampea 7 seeds cook more readily and are sweeter aside from being medium maturing and comparable to the local cultivars in size. However, the choice of Sampea 7 was based on the condition that insect pests are controlled. Without insecticides, farmers would prefer to continue to cultivate their local varieties. Of significance is the very poor preference given to IT82D-699 which yielded as high as Sampea 7. Farmers complained about the greenish white colour and smallness of the grains suggesting that the preference for a cultivar was not only based on grain yield.

CONCLUSION

Improved and local cowpea cultivars cultivated in relay system with millet and in mixture with sorghum/millet produced significantly higher grain yields with chemical insect pest control than without it. Unsprayed farmer's variety outyielded sprayed elite cultivars and produced yields similar to the highest yielding elite cultivars. However, not every local cultivar outyielded the elite ones. Grain yields of cowpea were higher in relay with millet than in sorghum/millet mixture. Farmers preferred the elite cultivar Sampea 7 most when insecticides were used, but preferred their local cultivars in the absence of insecticides. Farmer's preference for a cultivar was not only based on grain yield but also on quality.

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Table 1: Grain yield of cowpea in mixture with sorghum/millet and relay crop with millet as influenced by farmer, genotype and chemical insect pest control at Bomo Village.

	Cowpea grain yield (kg/ha)			
	Mixture with sorghum/millet		Relay crop with millet	
Treatment	1987	1988	1987	1988
Farmer				
1	667	360	1230	480
2	360	318	1054	436
SE ±	51.6	18.4	50.0	24.8
LSD	157.5	NS	150.8	NS
Cowpea genotype*				
IT84E-1-108	373bc	205d	653c	174c
IT84S-2246-4	509bc	332bc	920bc	441b
IT84E-124	353bc	223cd	603c	158c
IT81D-994	302c	251cd	1039b	394b
IT82D-699	530bc	319c	1441a	603a
Sampea 7	866a	417b	1446a	667a
Farmer var.1	NA	NA	1395a	NA
Farmer var.2	661ab	627a	1636a	761a
SE ±	96.5	34.5	100.1	46.4
Chemical Pest Control				
With	729	583	1471	864
Without	296	96	812	53
SE ±	51.6	18.4	50.0	24.8
LSD	157.5	56.3	150.8	75.7
Interaction				
Cowpea geno. x chemical insect pest control	NS	HS	HS	HS

* For cowpea genotype, means followed by same letter in a column are not significantly different at 5% level of probability (DMRT).
NA = Not applicable
NS = Not significant
HS = Highly significant

Table 2: Interaction effect of chemical i.. ı pest control and cowpea genotype on grain yield of cowpea in relay crop with millet in 1987 and 1988 and in mixture with sorghum/millet in 1988 at Bomo Village.

Cowpea genotype	Cowpea grain yield (kg/ha) in relay crop with millet (1987)* With CPC	Without CPC	Cowpea genotype	Cowpea grain yield (kg/ha) in mixture with sorghum/ millet (1988)* With CPC	Without CPC
IT84E-1-108	818de	489fg	IT84E-1-108	398d	13e
IT84S-2246-4	926de	915de	IT84S-2246-4	647ab	17e
IT84E-124	808de	399g	IT84E-124	429cd	18e
IT81D-994	1391c	687ef	IT81D-994	464cd	38e
IT82D-699	1996a	886de	IT82D-699	586bc	52e
Sampea 7	2111a	782e	Sampea 7	790a	46e
Farmer's var.1	1743b	1048d	Farmer's var.	766a	489cd
Farmer's var.2	1979ab	1293c	SE = ± 48.8		

SE = ± 141.5

Cowpea grain yield (kg/ha) in relay crop with millet (1988)*

Cowpea genotype	With CPC	Without CPC
IT84E-1-108	333c	16f
IT84S-2246-4	861b	21ef
IT84E-124	307cd	10f
IT81D-994	768b	20ef
IT82D-699	1177a	29ef
Sampea 7	1322a	31ef
Farmer's variety	1279a	244cde
S.E. = ± 65.6.		

* Within a year, means followed by same letter in both column and row are not significantly different at 5% level of probability (DMRT)
CPC = chemical insect pest control

Table 3: Pod maturity of cowpea in mixture with sorghum/millet combination and millet alone as influenced by farmer, genotype and chemical insect pest control at Bomo Village.

	Pod maturity (days) of cowpea			
	Mixture with sorghum/millet		Relay crop with millet	
Treatment	1987	1988	1987	1988
Farmer				
1	75.5	74.7	77.1	76.7
2	71.4	74.3	76.3	76.3
SE±	1.67	0.22	0.75	0.32
LSD	NS	NS	NS	NS
Cowpea genotype*				
IT84E-1-108	62.3c	63.5d	64.8d	67.0c
IT84S-224S-4	69.0bc	64.3d	64.8d	66.3c
IT84E-124	63.3c	63.0d	62.8d	63.3d
IT81D-994	76.3b	74.8c	75.8c	77.5b
IT82D-699	76.3b	75.8bc	74.5c	77.0b
Sampea 7	75.8b	76.5b	74.0c	77.0b
Farmer's var.1	NA	APP	APP	APP
Farmer's var.2	91.3a	103.8a	106.5a	107.5a
SE ±	3.13	0.41	1.50	0.60
Chemical pest control				
With	71.9	73.9	74.3	75.1
Without	75.0	75.1	79.0	77.9
SE ±	1.67	0.22	0.75	0.32
LSD	NS	0.31	2.26	0.97
Interaction Cowpea genotype x chemical insect pest control	NS	S	NS	S

*For cowpea genotype, means followed by same letter in a column are not significantly different at 5% level of probability (DMRT)

NS = Not significant NA = Not Applicable
S = Significant App = Applicable

Table 4: Interaction effect of chemical insect pest control and cowpea genotype on pod maturity of cowpea in mixture with sorghum/millet and in relay with millet in 1988 at Bomo Village.

	Pod maturity (days) of cowpea in mixture with sorghum/millet* (1988)			Pod maturity (days) of cowpea relay with millet* (1988)	
Cowpea genotype	with CPC	without CPC	Cowpea genotype	with CPC	without CPC
IT84E-1-108	63.5c	63.5c	IT84E-1-108	65.0f	69.0e
IT84S-2246-4	63.5c	65.0c	IT84S-2246-4	65.5f	67.0ef
IT84E-124	61.0c	65.0c	IT84E-124	61.0g	65.5f
IT81D-944	74.0b	75.5b	IT81D-994	74.5d	80.5b
IT82D-699	76.0b	75.5b	IT82D-699	76.0cd	78.0bc
Sampea 7	75.5b	77.5b	Sampea 7	77.0cd	77.0cd
Famer's variety	103.5a	104.0a	Farmer's variety	107.0a	108.0a
S.E. = ± 0.59			S.E. = ± 0.85		

* For a system, means followed by same letter in both column and row are not significantly different at 5% level of probability (DMRT).

CPC = Chemical insect pest control.

Table 5: Cowpea 100-grain weight in mixture with sorghum/millet combination and millet alone as influenced by farmer, genotype and chemical insect pest control at Bomo Village.

	Cowpea 100-grain weight (g)			
	Mixture with sorghum/millet		Relay crop with millet	
Treatment	1987	1988	1987	1988
Farmer				
1	18.4	15.6	18.6	16.2
2	18.3	16.1	17.3	16.4
SE ±	0.73	0.08	0.56	0.27
LSD	NS	NS	NS	NS
Cowpea genotype*				
IT84E-1-108	17.2bc	13.3c	16.5bcd	14.8c
IT84S-2246-4	15.0c	12.5c	14.8cd	13.6cd
IT84E-124	18.1abc	13.2c	15.9bcd	13.6cd
IT841D-994	20.9ab	20.7a	23.0a	21.6a
IT82D-699	15.1c	13.3c	13.8d	12.5d
Sampea 7	20.3ab	18.0b	19.2ab	18.3b
Farmer's var.1	NA	NA	NA	NA
Famer's var.2	21.9a	19.7ab	22.6a	19.9ab
SE ±	1.37	0.54	1.12	0.51
Chemical pest control				
With	18.8	16.5	17.5	16.3
Without	17.9	15.2	18.4	16.3
SE ±	0.73	0.08	0.56	0.27
LSD	NS	0.08	NS	NS
Interaction				
Cowpea genotype x chemical insect pest control	NS	NS	NS	NS

* For cowpea genotype, means followed by same letter in a column are not significantly different at 5% level of probability (DMRT).
NS = Not significant
NA = Not applicable
CPC = Chemical insect pest control

Table 6: Farmer's assessment* of cowpea genotypes in sorghum/millet/cowpea mixed cropping system at Bomo Village.

	1987						1988					
	Farmer 1 preference at		Farmer 2 preference at		Mean	Rank	Farmer 1 preference at		Farmer 2 preference at		Mean	Rank
	plant-ing	harvest	plant-ing	harvest			plant-ing	harvest	plant-ing	harvest		
IT84E-1-108	5	6	5	3	4.75	4	1	4	6	6	4.25	4
IT84S-2246-4	6	7	3	6	5.50	6	2	7	4	4	4.25	4
IT84E-124	7	4	6	2	4.75	4	5	6	5	7	5.75	6
IT81D-994	3	1	1	7	3.00	2	7	2	3	1	3.25	3
IT842D-699	4	5	7	5	5.25	5	6	5	7	5	5.75	6
Sampea 7	1	3	2	1	1.75	1	3	1	2	2	1.75	1
Farmer's-variety	2	2	4	4	3.00	2	4	3	2	3	3.00	2

*The higher the figure, the less is the preference.

Table 7: Farmer's assessment* of cowpea genotypes in millet/cowpea relay cropping system at Bomo Village.

	1987						1988					
	Farmer 1 preference at		Farmer 2 preference at		Mean	Rank	Farmer 1 preference at		Farmer 2 preference at		Mean	Rank
	plant-ing	harvest	plant-ing	harvest			plant-ing	harvest	plant-ing	harvest		
IT84E-1-108	3	3	4	3	3.25	3	7	6	7	7	6.75	7
IT84S-2246-4	2	6	3	4	3.75	4	3	2	5	1	2.75	3
IT84E-124	7	8	8	7	7.50	7	6	4	4	4	4.5	5
IT81D-994	6	2	1	2	2.75	2	2	5	1	2	2.5	2
IT842D-699	8	7	7	8	7.50	7	5	7	6	6	6.0	6
Sampea 7	1	1	2	1	1.25	1	1	3	2	3	2.25	1
Farmer's variety 1	5	5	6	5	5.25	6	----------not applicable----------					
Farmer's variety 2	4	4	5	6	4.75	5	4	1	3	5	3.25	4

*The higher the figure, the less is the preference.

ON-FARM EVALUATION OF IMPROVED CASSAVA VARIETIES IN THE TROPICAL RAINFOREST ZONE OF NIGERIA

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SUMMARY

The total mixture and individual productivity of three improved cassava varieties (TMS 30572, TMS 50395, and U/41044) and Nwanyiocha (local best variety) intercropped with improved maize (TZE-SR-Y) were estimated under the farmers' production conditions in the tropical rainforest, acid soils of Rivers State of Nigeria. The objective was to find out an appropriate higher yielding cassava/maize production alternative to the existing farmers' practice through on-farm testing of prototype technologies developed at the National Root Crops Research Institute (NRCRI) Umudike and International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria.

The improved varieties out-yielded the local best variety by 470 to 600%, an average of 531%. Among the improved varieties of cassava, TMS 30572 gave the highest yield. However, in terms of productivity of the system, U/41044/maize was the most productive as determined by bivariate analysis. With respect to response to the environments, TMS 50395 yielded highest in good environments, while in poor environments, TMS 30572 should be preferred.

Keywords: Total mixture, individual productivity, improved varieties, intercropping.

RESUME

La performance collective et la productivité individuelle de trois variétés de manioc améliorées (TMS 30572, TMS 50395, et U/41044) ainsi que celle de la meilleure variété locale (*Nwa-nyiocha*) cultivées en association avec le maïs amélioré, (TZE-SR-Y) ont été évaluées dans les conditions de production paysannes. Les essais ont eu lieu sur les sols acides de la forêt guinéene de l'Etat de Rivers au Nigéria. L'objectif était de découvrir une alternative (rendement plus élévé de la production de manioc ou de maïs) à la pratique actuelle des paysans, au moyen d'une vérification sur place des prototypes technologiques mis au point au National Root Crops Research Institute (NRCRI) à Umudike et à l'Institut International d'Agriculture Tropicale (IITA) à Ibadan, au Nigéria. Le rendement des variétés améliorées a dépassé celui de la meilleure variete locale de 470 à 600% avec une moyenne de 531% . Parmi les variétés améliorées de manioc, (TMS 30572) a donne le rendement le plus élevé. Toutefois du point de vue de la productivité du système, l'association U/41044/maïs a été la plus productive selon une analyse bi-variee.

En ce qui concerne la réaction face aux conditions du milieu, TMS 50395 a donné le rendement le plus élevé dans les conditions favorables, alors que dans des conditions difficiles, TMS 30572 serait préférable.

Mots clés: Performance collective, productivité individuelle, variétés améliorées, association de cultures.

INTRODUCTION

Multiple cropping is a common feature in South-Eastern Nigeria. The most common crop combinations is yam/maize/cassava/ vegetable/egusi melon (Unamma *et al,* 1985). However, the dominant crop associations varied with different areas of the zone. In Rivers State, for example, Unamma *et al* (1985) observed that cassava/maize/ egusi was the commonest crop combination. Ezulike *et al* (1986), however reported high incidences of pests and diseases (notably, cassava green mite, cassava mealybug, cassava mosiac virus diseases, cassava anthracnose disease) on the local cassava varieties commonly grown in the area. This constituted a major production constraint in the zone. Cassava yields were reduced considerably (5t/ha, Unamma *et al* 1985), and in some cases total crop failure resulted from the damage caused by pests and diseases. National Root Crops Research Institute (NRCRI) Umudike and International Institute of Tropical Agriculture (IITA), Ibadan have bred cassava varieties that are high yielding and considerably tolerant to common pests and diseases of cassava. The objective of this trial was to evaluate three improved and one local best cassava variety under the farmer's cropping conditions in order to determine

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the adaptability of IITA and NRCRI developed prototype technologies under farmer's conditions in a humid tropical rainforest zone of Nigeria.

MATERIALS AND METHODS

The trial was conducted in the farmers' fields in Port-Hacourt, Bori and Etche Agricultural Development Project zones of Rivers State of Nigeria. The sites lie between 4°20' N - 5°12' N and 6°40"E - 7°37' E. The climate is controlled by the inter tropical convergence zone resulting from two air mases, namely the South Westerly moisture ladden monsoon winds and the north-easterly dry-hammatan winds. The study areas are characterised by high rainfall (2396mm annually), which is bi-modal in nature with peaks in June and September. Mean monthly rainfall ranges between 98 and 871mm during the wet season (February - November) and 32 - 110mm during the short dry season. The mean annual temperature ranges between 26°C and 27°C. The locations lie within the tropical rainforest zone or what is now called secondary forest with oil palm as the dominant speicies. The trial sites were followed for 2, 3 and 4 years, respectively and the soil chemical characteristics are shown in Table 1. Traditional land preparation method was adopted. This consisted of clearing, burning, digging of holes which are covered up again with earth to form just small hills over the holes. Four treatments comprising three improved cassava varieties, TMS (Tropical Manihot Series) 30572, TMS 50395 (from IITA) and U(Umudike)/41044(fromNRCRI, Umudike) and one local variety (Nwanyiocha) were evaluated under cassava/maize intercropping system. Improved maize variety TZE-SR-Y was used in all the plots. Randomized complete block design in three replications per location was used. Each farmer represented a replication and the trial was researcher-managed. Plot size was 5m x 10m. Cassava was planted at 1m x 1m spacing (10,000 i.e. plants/ha) on the crest of the small mounds. Maize was also planted at a spacing of 1m x 1m (2 seeds/hole) at the foot of the mounds (about 25m away from cassava stands). This gave a population of 20,000 plants/ha. Other cultural operations included manual weeding at 3 and 8 weeks after planting; application of 400 kg/ha of N.P.K. Mg 12:12:17:2 at 4 weeks after planting by banding between the cassava and maize rows.

Component crops yields, pests and diseases (using scale 1-5) were first analysed using univariate analysis of variance. Secondly, the yields of both crops were analysed in pairs so as to look at their convariances. i.e. mixture interactions (Pearce and Gilliver, 1979; Dear and Mead, 1983.) If the yields of cassava and maize for any given plot be X_1 and X_2 respectively, the analysis of variance and covariance give the residual (error) variance of X_1 and X_2 respectively as V_{11} and V_{22} and the residual convariance as V_{12}. The residual cooefficient "r" is given by

$$r = \frac{V_{12}}{\sqrt{V_{11} \times V_{22}}} = \cos\theta$$

If there is competition between the component crops, "r" would be expected to be negative and angle O would lie between 90° and 180°. If "r" is positive, angle Θ would be between 0 and 90°.

Graphical presentation of bivariate (X_1, X_2) coordinate pair with skew axes was used (i.e. non-perpendicular axes) using tranformed variables. Y_1, Y_2 for X_1 and X_2, respectively. Therefore

$$Y_1 = \frac{X_1}{V_{11}}, \quad Y_2 = \frac{X_2}{V_{22}}$$

$$Y = \frac{(X_2 - \frac{V_{12}X_1}{V_{11}})}{\sqrt{(V_{22} - \frac{V_{12}X_2}{V_{11}})}}$$

These new variables Y_1, Y_2 would serve:

1. In fitting the skew graph unto rectangular paper.
2. In constructing standard errors and, confidence intervals.

The bivarate F values and F test were performed. Circles of non-significance regions were drawn with the centres at the coordinate points. Any two means must be 3 radii to be significant.

Finally, yield stability analysis (Hildebrand, 1984) was used to estimate probable recommendation domains.

RESULT AND DISCUSSIONS

Maize yield was generally poor and not significantly affected by cassava variety (Table 2). The only differences detected in maize yields were due to location. Highest yields were obtained in Etche. Yields in Bori and Port-Hacourt were similar. The chemical analysis of the soils of the trial sites (Table 1) shows that they were characteri-

sed by low Nitrogen and pH. The organic matter content was low in Bori and Port-Hacourt areas but medium in Etche. These soil conditions may have contributed to the poor yield of maize as Karim (1985) and Rana *et al*, (1986) have shown that maize yield was decreased with decrease in nitrogen level. The fresh root yields of improved cassava varieties were similar, but were all significantly (1% level of probability) better than local best variety (Table 2). The yield of the local variety was 14.3, 16.0 and 17.6% of the yields produced by TMS 30572, TMS 50395 and U/41044, respectively. Location also had significant influence on the performance of cassava varieties. Highest fresh root yield was obtained from Bori while yields from Port-Hacourt and Etche were similar.

No serious insect and rodent pest damages were oberved on any of the varieties including the local. However, two diseases Cassava Mosaic Virus Diseases (CMVD) and Cassava Anthracnose occured. Since trend of infestation in different locations was the same, only the means across locations are presented in Table 3. Cassava Mosaic Virus Diseases (CMVD) was more on the local variety (with damage score of 5) than on the improved cassava varieties. Cassava Anthracnose Diseases (CAD) affected TMS 30572 and TMS 50395 but not U/41044 and the local variety. Since yields of the CAD-affected varieties were not reduced, but those CMVD - affected varieties were, it may be deduced that CAD is a less important disease of cassava than CMVD on the varieties used.

One of the farmer's objectives in practising intercropping is to achieve optimum yields and returns from the component crops. In order to assess the productivity of the system, the root yield of cassava was regressed with the grain yield of maize (bivariate analysis) using the model of Pearce and Gilliver (1979) and Dear and Mead (1983). This analysis (Fig. 2) indicated that maize yield was highest in the maize/cassava mixture when local cassava was used. Although there were no significant differences in both maize and improved cassava yields, the farmers may prefer the variety that would ensure higher returns. The variety U/41044 gave 8.8 and 5.7% greater net benefit than varieties TMS 30572, TMS 50395, respectively (Table 2). For purpose of partitioning the area into recommendation domains, the root yield of each cassava variety was regressed against the average yield of the varieties across the sites (i.e. environmental index, Hildebrand,(1984)). The coefficients of determination (R^2 value) for the local variety were low and therefore stable with the environment. Thus, the local cassava variety yielded poorly in both good and bad environments. On the other hand, the improved varieties with higher R^2 value were unstable. Under poor environment (i.e. those with environmental index of less than 13 t/ha) of Port-Hacourt and Etche TMS 30572 would be preferred, but under good environment (i.e. with average yield of more than 13 t/ha) of Bori TMS 50395 out-yielded the others. The analysis also showed that the improved varieties were superior to the local variety which may produce zero yield even in good environments.

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Table 1: Chemical characteristics of the soil of the trial sites, Rivers State, Nigeria, 1987

Location	Ca	Mg	K	Na	P (ppm)	O.C	OM.	N	pH (H_2O)	pH (HCL)
Port Harcourt	1.15	.172	.171	2.109	2.69	1.31	2.25	.109	5.00	4.00
Bori	0.45	. 35	.121	.139	1.58	0.70	1.20	.065	5.17	4.37
Etche	1.34	. 80	.140	.168	3.04	1.66	3.05	.175	5.60	4.77

Table 2: Effect of cassava varieties and location on yields of component crops in cassava/maize intercrop.

Treatment (Cassava Variety)	Maize yield (t/ha)	Cassava yield (t/ha)	Net benefit (Naira/ha)
TMS 30572 + Maize	Bori : 0.39 Etche : 1.27 Port-H.: 0.83 Mean : 0.82	Bori : 24.4 Etche : 13.7 Port-H.: 16.4 Mean : 18.2	10311.7
TMS 50395 + Maize	Bori : 0.33 Etche : 1.23 Port-H.: 0.83 Mean : 0.80	Bori : 28.0 Etche : 7.2 Port-H.: 13.3 Mean : 16.2	10611.7
U/41044 + Maize	Bori : 0.31 Etche : 1.45 Port-H.: 0.80 Mean : 0.85	Bori : 27.7 Etche : 10.0 Port-H.: 10.7 Mean : 14.8	11215.0
Local Cassava + Maize	Bori : 0.31 Etche : 1.44 Port-H.: 0.80 Mean : 0.85	Bori : 1.4 Etche : 3.3 Port-H.: 3.2 Mean : 2.6	2,320
Location Mean	Bori : 0.46 Etche : 1.35 Port-H.: 0.80	Bori : 19.4 Etche : 8.6 Port-H.: 10.9	

LSD (a)	Location	0.28	5.3
(b)	Cassava variety	NS	4.9
	CV	12%	32.7%

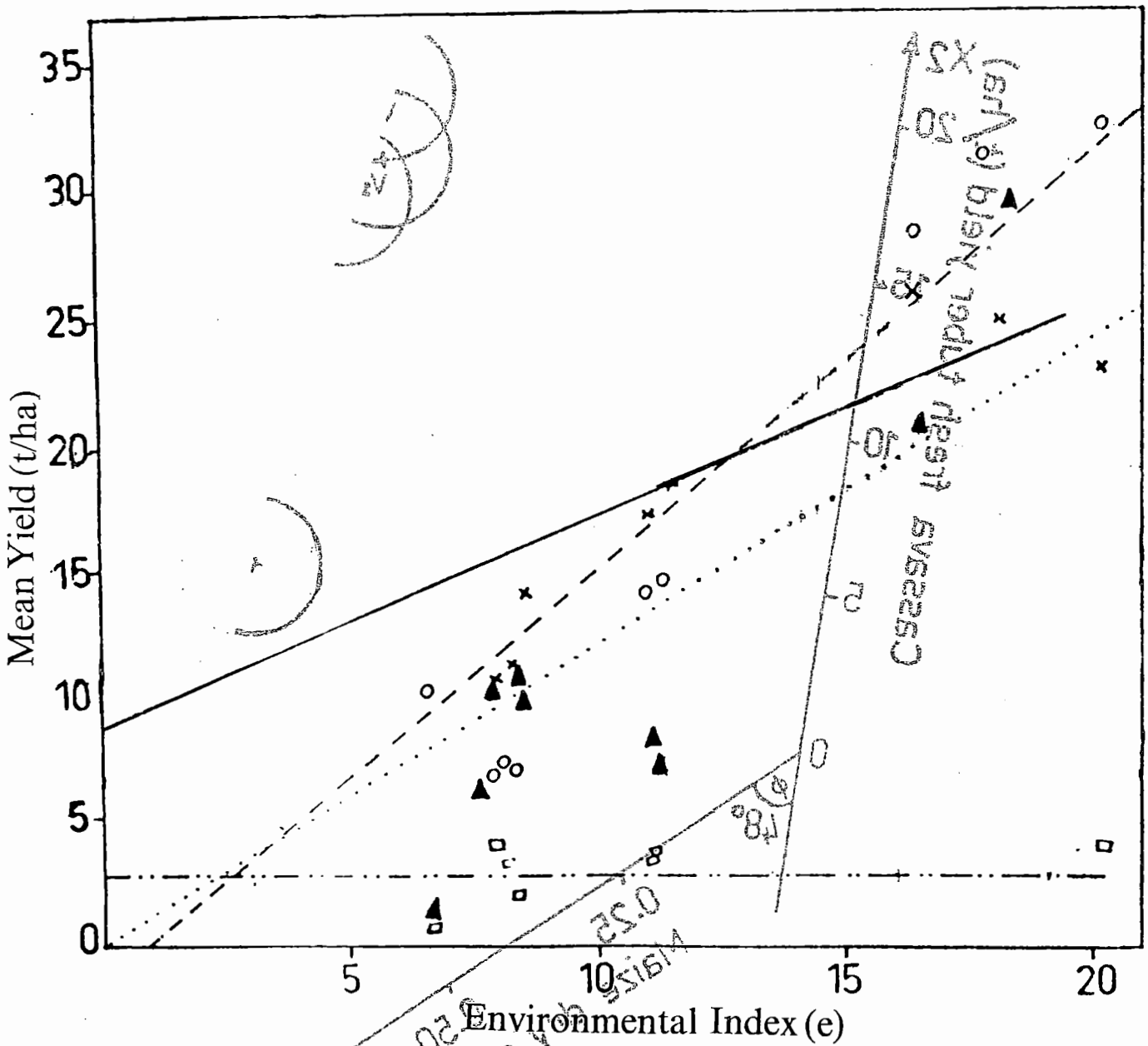
Table 3: Damage score of diseases on cassava varieties intercropped with maize in Rivers State, Nigeria 1987/88

Treatment (Cassava varieties)	Cassava Mosaic Virus Disease (CMVD)*	Cassava Anthracnose Disease (CAD)*
TMS 30572 + Maize	2.0 + 0.0	1.7 + 0.6
TMS 50395 + Maize	2.0 + 0.0	2.0 + 0.0
U/41044 + Maize	2.7 + 0.6	0.0
Local + Maize	4.3 + 0.0	0.0

Each figure is the mean score of six replications

* 1 = No damage
5 = Complete damage.

Figure 1: Yield response of local (L) and improved TMS 30572, TMS 50395 and U/41044 varieties to the environment.



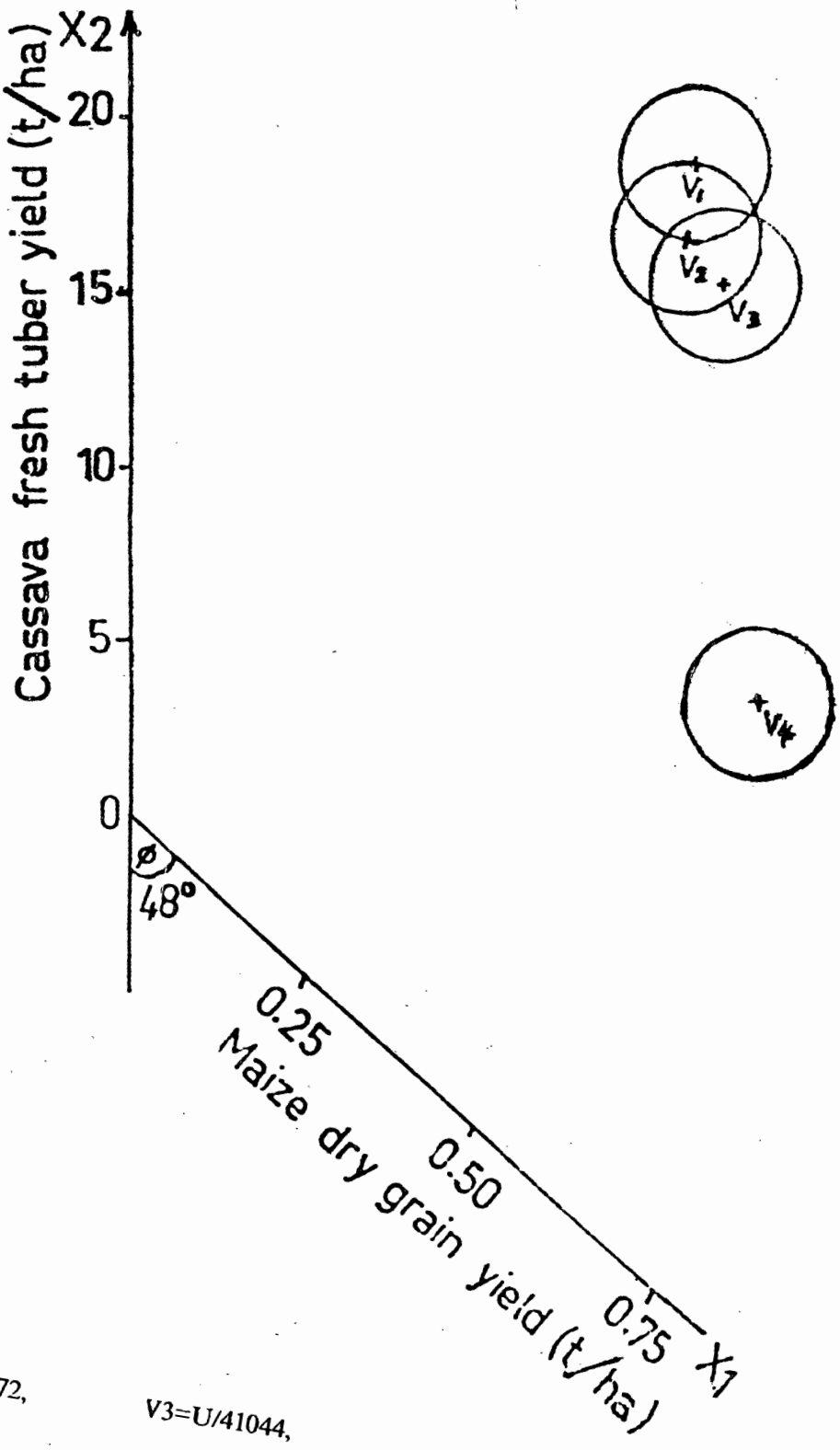
X—X $Y_{TMS30572} = 8.35 + 0.88\ X$ ($R^2 = 0.84$)

O- - -O $Y_{TMS50395} = -1.28 + 1.56\ X$ ($R^2 = 0.80$)

▲·····▲ $Y_{U/41044} = -0.10 + 1.2\ X$ ($R^2 = 0.70$)

□- ··—··-□ $Y_L = 3.0 - 0.10\ X$ ($R^2 = 0.074$)

Figure 2: Graphical assessment of cassava and maize yields as affected by cassava variety



V1=TMS 30572, V3=U/41044,

V2=TMS 50395, V4=Local variety.

Circles represent 5% non-significance regions.

R=0.667

AN ASSESSMENT OF FARMERS' PERCEPTION OF THE FERTILIZER SUB-SECTOR REFORM PROGRAMME AT VILLAGE LEVEL IN WEST PROVINCE OF CAMEROON

NYEMBA AMBELA Jean[1]

SUMMARY

Components of farming systems include actors like farmers, researchers, educators, government, and sub-sectors like industry, market, and input supply. All these components and corresponding actors interact within the framework of extension programmes to bring changes in the production processes. This study analyzed the perception by farmers of the Fertilizer sub-sector reform program started in 1988 by both the Cameroon government and USAID in the West Province to improve the fertilizer importation and distribution systems.

One hundred and seventy-two (172) households were selected at random and interviewed. The results suggest that even though the new fertilizer distribution was not perceived to be very different from the previous one, the quality delivered was good but the cost was too high at village level. This limited the possibility of buying as much fertilizers as needed. The level of knowledge about fertilizer was generally low and, even though farmers could physically indentify some of the types available they could not say much about how to apply them. The quantities used in 1990 were relatively smaller compared to the amounts used in previous years. This negatively affected the household income level.

Keywords: Farming systems, supply, farmers, program impact assessment.

RESUME

Les composantes des systèmes agraires sont des éléments tels que les paysans, les chercheurs, les instructeurs, le gouvernement et des sous-secteurs tels que l'industrie, le marché et l'approvisionnement en intrants. Toutes ces composantes et les acteurs correspondants agissent souvent les uns sur les autres dans le cadre des programmes de vulgarisation pour apporter des changements dans le processus de production. Cette étude analyse la perception qu'ont les paysans du programme de réforme du sous-secteur des engrais initié par le gouvernement du Cameroun et l'USAID en 1988. Le but de cette réforme était d'améliorer les systèmes d'importation et de distribution des engrais.

Cent soixante-douze (172) ménages furent choisis au hasard et interviewés. Les résultats montrent que même si pour les paysans, le nouveau système de distribution des engrais ne différait pas de l'ancien, la qualité actuelle était meilleure, mais les coûts trop élevés au niveau villageois. Cela limitait la possibilité d'acheter de l'engrais en quantité voulue. Le niveau de connaissance des paysans en matière d'engrais était généralement bas et, même s'ils pouvaient reconnaître physiquement les types d'engrais disponibles il n'en était pas de même en ce qui concerne les modes d'application de ces engrais. Les quantités utilisées en 1990 étaient inférieures à celles des années antérieures. Ceci a contribué à réduire encore davantage les revenus des ménages.

Mots clés: Systèmes de production, cultivateurs, approvisionnement, évaluation de l'impact du programme.

INTRODUCTION

The Fertilizer sub-sector Reform Programme in Cameroon is an agricultural policy reform which involves both institutional and strategy changes. It is a shift from public or government monopoly to a private system of fertilizer importation and distribution, expected to result in better, efficient knowledge, and use of fertilizer at farm level. The programme started in 1988 and is expected to end in 1993. Two years after inception (1990) the Technical Supervisory Committee, USAID and the Government of the Republic of Cameroon requested for an impact assessment of the fertilizer programme at farm-level.

This study therefore describes the farm-level impact of the Fertilizer Sub-sector Reform Programme (FSSRP) in the West Province of Cameroon, identifies the constraints, achievements, the decision-making orientations, and the diffusion of innovations in rural areas.

METHODOLOGY

The study was carried out in the West Province of Cameroon which covers 14,000 square kilometers and had about 1.3 million inhabitants in 1986. Proportionally, the

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West Province represents about 3% of the total land area and 13% of the total population of Cameroon. The population density is quite high (96 inhab/km^2). Of the six administrative divisions of the province, one (Noun) covers about 55% of the total area.

Despite being the smallest in size; the West Province stands out as an important agaricultural producer. It has relatively fertile soils, and its population is highly engaged in agricultural activities (production, marketing, processing, and distribution). Most of the agriculture in the province is traditional and the average area is about 1.80 ha for food and export crops (coffee) combined. The relative importance of the province in the national agricultural production is given in Table 1.

Fertilizer consumption is an indicator frequently used for describing the level of agricultural modernization and development. The 1984 Agricultural Census reported that 80% of the farmers in the West Province used fertilizer while the national average was only 45%. The same census indicated that in absolute terms, the West Province as a whole consumed 140,240 tons, representing 51% of the national consumption. After the fertilizer sub-sector privatization in 1987, fertilizer consumption had not changed very much. The Agricultural Marketing Improvement Strategy (AMIS) reported that the West Province ordered 56% and 42% of fertilizer in 1988 and 1989 respectively.

The study population consisted of all agricultural households of the six administrative divisions of the West Province which were: Bamboutos, Haut-Nkam, Mifi, Menoua, Nde and Noun. The households were assisted by six powerful coffee cooperatives which formed a big union called "Union Centrale des Coopératives Agricoles de l'Ouest" (UCCAO).

One hundred and seventy-two households were chosen at random from selected villages of the West Province. Their distribution by division is presented in Table 2. A questionnaire was used to collect information. Fourteen (14) students were selected and trained as enumerators. Two students were sent to each division except Menoua and Noun divisions which were surveyed by three students each. In order to facilitate the language problem, all the 14 students selected were natives of the West Province and they were stationed in divisions where they had no communication problems. The main weakness of the questionnaire were indentified during testing and corrected prior to the final administration. Descriptive statistics were used to examine and describe the trends in the data.

RESULTS AND DISCUSSIONS

Four outcomes were hypothesized in the study as a result of the fertilizer sub-sector reform:

1. Fertilizers would be available at relatively lower prices, and better quality at farm level.

2. The new distribution system would be very positively evaluated by farmers at village level.

3. Adoption and use of fertilizers would be high at farm level.

4. Farmers would exhibit higher knowledge about fertilizers at farm level.

Perceived quality of fertilizers

The farmers' perception of the quality of fertilizers delivered are presented in Table 3.

Most farmers seemed to agree that the quality of the fertilizers delivered at farm level was good, at least for the few who could afford to buy them.

Perceived Cost of Fertilizer and Evaluation of the new distribution system by Farmers

Farmers in the selected households were asked to give their opinion about the new fertilizer distribution system, and to talk about the way they perceived the relative cost of fertilizers at village level. From the results in Table 4, the new distribution system appears to be the same as before. This finding is congruent with background information that delays in granting importation and distribution loans often result in delays in fertilizers reaching the farmers.

The reasons for dissatisfaction with the new distribution system were also investigated. The results are summarized in Table 5. The major reasons for dissatisfaction with the new fertilizer distribution system as perceived by farmers were the high cost of fertilizers, the limited quantity needed and the late arrival at farm level.

Level of knowledge, adoption and use of fertilizer at farm level

In the West Province of Cameroon, farmers in the selected households get information on fertilizers from various sources:

cooperatives (9.30%), extension agents (87.80%), other farmers (14.54%), radio (16.86%), personal experience (34.30%) or a combination of these various sources (47.1%). The findings suggest that extension agents are very active in the study area, as well as the farmers themselves in seeking appropriate information.

The findings on the types of fertilizers already used as a measure of their knowledge indicate that 93.60% of the farmers in the selected households knew NPK 20-10-10 and used it all the time, 84.47% knew and used ammonium sulfate, 84.88% knew and used urea, 57.56% knew and used NPK 12-06-20, and on the average about 63% of farmers used various combinations of the above. Potassium (8.14%) and bicalcic phosphate (4.07%) were little known and used in the study area. With respect to the types of fertilizers that worked better when covered by soil, the findings show that the majority of farmers (64.1%) simply did not know which ones. It was therefore clear that even though farmers could recognize the various fertilizer types, some technicalities associated with their use were not well known. The figures in Table 6 suggest that most farmers in the selected households did not use fertilizers in significant amounts, considering the high rates of no responses which were 54.1% for urea, 71.5% for ammonium sulfate, and 72.7% NPK 12-06-20. This rate is low for NPK 20-10-10. For those farmers who answered the question, 40% did not use anything at all.

The reasons for not using much fertilizer are many, but the most important must have been the fact the price of coffee was down thus negatively affecting the income level of rural households.

CONCLUSION

Investigations were carried out in the West Province of Cameroon in 1990 to assess the level of fertilizer use by farmers among 172 randomly selected households in the province.

The findings suggested that the quality of the fertilizers delivered was good at farm level, the new fertilizer distribution system was somewhat the same as before, and the cost of fertilizers was very high at village level. The high cost of fertilizer limited the possibility of buying as much fertilizers as needed. The level of knowledge about fertilizers in terms of types, quantities and mode of application was generally low. As a matter of fact, farmers knew and could recognize some of the types of fertilizers available (NPK 20-10-10, urea, ammonium sulfate) but were unable to say much on how to apply them properly. The quantities used were very little in 1990 because the price of coffee fell thereby negatively affecting the income of rural households.

The Fertilizer Sub-sector Programme was based on the assumption that the price of coffee (the main export crop concerned) would remain stable, and that farmers could still make profit even if fertilizers were not subsidized. The rationale was that the inefficiency of the public sector in importing and in distributing fertilizers would be alleviated and, in liberalizing the fertilizer subsector, farmers would have fertilizers on time, in good quality and at acceptable prices.

To achieve these objectives, given the drop in the coffee producer's price, it is recommended that loan schemes be designed for farmers for the purpose of purchasing fertilizers in order to maintain their farm productivity. Extension programmes should emphasize income generating food crops such as corn, beans, soyabean, cowpea and plantains that are grown in association with coffee and can take advantage of the available fertilizers. Existing cooperatives should be re-organized to enable them handle some aspects of the marketing of other commodities depending on identified problem areas at producer's level.

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Table 1: Relative importance of the West Province in the production of some selected crops (metric tons)

Crops (1)	West Province (2)	Cameroon (3)	Percentage (2)/(3) x 100
Arabic Coffee	20,992	36,837	57.0
Robusta coffe	31,112	107,966	28.8
Maize	99,717	387,712	25.7
Cocoyams/Taro	44,842	233,150	19.2
Robusta coffee	37,732	106,817	35.3
Maize	11,765	26,747	44.0

Source: 1984 Agricultural Census, Department of Agricultural Statistics and Survey, Ministry of Agriculture, Yaounde, Cameroon.

Table 2: Distribution of households according to administrative division.

Administrative division	Number interviewed	Percent
Bamboutos	33	19.2
Haut-Nkam	21	12.2
Mifi	21	12.2
Noun	36	20.9
Ndé	25	14.5
Menoua	35	20.4
No response	1	0.6
Total	172	100

Table 3: Percentage for whom quality of fertilizer was good

	Frequency	Percent
No	1	0.6
Not quite	16	9.3
Yes	83	48.2
No response	72	41.9
Total	172	100

Table 4: Opinion about the new fertilizer distribution system

Opinion	Frequency	Percent
Worse than before	36	20.9
Somewhat bad	33	19.2
Same as before	46	26.7
Somewhat good	32	18.6
Better than before	5	2.9
Others	12	7.0
No response	8	4.7
Total	172	100

Table 5: Reasons for dissatisfaction with the new distribution system

	Number agreeing with reason	Number not agreeing with reason	No response	Total
No possibility to buy as much as before	49 (28.49%)	65 (37.39%)	58 (33.75%)	172 (100%)
Fertilizer always arrive late	19 (11.05%)	95 (55.23%)	58 (33.75%)	172 (100%)
Quantity available is very limited	11 (6.40%)	103 (50.88%)	58 (33.75%)	172 (100%)
Few types are available	29 (16.86%)	85 (49.42%)	58 (33.75%)	172 (100%)
Cost is very high	79 (45.93%)	35 (20.35%)	58 (33.75%)	172 (100%)
No credit available	29 (16.86%)	85 (49.42%)	58 (33.75%)	172 (100%)
Selling point very far	28 (16.28%)	86 (50.00%)	58 (33.75%)	172 (100%)

Table 6: Quantity of fertilizers used in 1990 (50 kg bags)

	Urea (%)	sulfate ammonium (%)	NPK 20-10-10 (%)	NPK 12-06-20 (%)	All Types (%)
0 bag	11.0	11.6	6.4	11.0	40.0
less than 5 bags	22.7	7.6	21.5	10.5	11.7
6 - 10 bags	6.4	3.0	16.3	1.2	15.1
11 - 20 bags	2.3	2.3	7.6	1.7	12.8
21 bags and more	3.5	4.1	11.0	2.3	20.4
No response	54.1	71.4	37.2	73.3	
Total	100	100	100	100	100
Average ($\bar{X}_1$)	2.0	1.50	3.59	1.28	2.80
Average outliers ($\bar{X}_2$)	35.62	23.50	30.81	29.43	24.90

PERFORMANCE OF THE NIGERIAN SEED COTTON MARKET UNDER THE DEREGULATED MARKETING SYSTEM.

A.D. Barau[1], J.O. Olukosi[1], and Y.A. Amin[1]

SUMMARY

Informed by the failure of the different generations of marketing boards in the country, and in the spirit of the Structural Adjustment Programme (SAP), the Federal Government of Nigeria abolished the seven commodity marketing boards in 1986. Since then cotton marketing has been completely under the deregulated marketing system.

This study was undertaken to determine whether the innefficiencies associated with the previous government-organized produce marketing strategies have been eliminated under the current free enterprise system. Data were collected from a total of 75 cotton farmers, 15 cotton buying agents, 12 cotton merchants, and three (3) cotton-ginning companies spread across Bauchi, Kaduna, Katsina, and Sokoto State of Nigeria during the 1991/92 cotton season.

Marketing performance were assesed using three measures of marketing efficiency - namely,the Gini Coefficient, the Herfindahl Index, and the Coefficient of Variability. The results of the analyses showed that marketing efficiency has increased under the free market system relative to the previous marketing arrangement.

The study, however, showed that grading of the commodity was no longer commonly practised as the buyers usually went after the produce in the farmers' homes and farms rather than wait for it at gazetted markets. This was identified as the greatest limitation of the free marketing system for seed cotton in the country.

Keywords: Marketing strategies, seed cotton, marketing performance, SAP.

RESUME

Tirant leçon des échecs de différentes générations de compagnies de commercialisation dans le pays, et dans l'esprit du Programme d'Ajustement Structurel (SAP), le Gouvernement Fédéral du Nigéria a supprimé en 1986 les sept sociétés de commercialisation des produits agricoles. Dès lors, la commercialisation du coton s'est effectué sous le système de marché dérégulé.

Cette étude a été menée pour déterminer si les insuffisances qu'on reprochait aux stratégies de commercialisation précédemment mises en place par le gouvernement ont disparu sous le système de libre entreprise. Des données ont été collectées auprès de 75 paysan cultivant le coton, 15 agents d'achat, 12 négociants de coton et 3 sociétés d'égrenage qui se répartissent dans les Etats de Bauchi, Kaduna, Kastina et Sokoto au Nigéria pendant la campagne cotonnière de 1991/92.

La performance du marché a été évaluée au moyen de trois indicateurs d'efficacité de la commercialisation à savoir le Coefficient de Gini, l'Index de Herfindahl et le Coefficient de Variabilité. Les résultats des analyses ont montréque, comparativement au système de commercialisation précédent, l'efficacité de la commercialisation du coton s'est accrue sous le système de marché libre.

Cette étude a montré cependant que le classement des produits n'était plus appliqué puisque les acheteurs vont désormais chercher les produits chez les paysans et dans leurs champs au lieu d'attendre aux marchés officiels. Ceci était identifié comme la plus grande insuffisance du système de marché libre du coton graine dans le pays.

Mots clés: Stratégies de Commercialisation, coton graine, performance du marché, PAS.

INTRODUCTION

Following the introduction of the StructuralAdjustmentProgramme (SAP) in 1986, a number of measures were taken aimed at restructuring the Nigerian economy towards achieving sunstainable economic growth and development. Such measures included trade liberalization, privatization and commercialization of public companies, deregulation of exchange rates and promotion of non-oil exports. The agricultural sector received considerable attention in the implementation of these measures since it is the most important potential source of non-oil exports. One of the strategies employed to stimulate increased agricultural production in the country was the deregulation of agricultural produce marketing. This was done through the abolition of the seven commodity marketing boards which, from

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1977 to 1986, were responsible for organizing the marketing of Nigeria's major agricultural produce. These comprised the Cotton, Grains, Cocoa, Palm Produce, Groundnut, Rubber and the Root/Tuber Crops Boards (Olukosi and Isitor, 1990).

The abolition of these boards was informed by their identified inefficiencies and other activities which, like those of their predecessors, (the Commodity Marketing Boards 1948-1954 and the Regional Marketing Boards 1954-1977) were found to be inimical to farmers' earnings and hence incentive to expand production. For example, largely as a result of the malpractices resulting from the activities of the Nigerian Cotton Board (NCB), production of the crop dropped from an aggregate output level of 440,000 bales (181.43 kg average weight) in 1977 to just a little over 50,000 bales in 1986. It was in order to remove these obstacles to expanded cotton production (among other major cash crops) that the marketing board system was abolished and replaced with a competitive and free enterprise marketing system as from 1986.

The primary question addressed in this study, therefore, is "to what extent have the deficiencies of the previous marketing arrangements been eliminated under the current system particularly in respect of market conduct/performance and prices received by farmers? Consequently, the objectives of the study are as follows:

(i) to analyze the market structure for seed cotton marketing under the free-market system in Nigeria;

(ii) to assess the role of the private sector in seed cotton marketing; and

(iii) to assess the impact of deregulation on the efficiency and performance of the seed cotton market in the country.

STUDY METHODOLOGY

The data for this study were collected between January and May 1992 from a sample of 75 cotton farmers, 15 cotton buying agents, 12 cotton merchants and three cotton ginning companies in four states, namely; Bauchi, Kaduna, Katsina, and Sokoto. The data were collected by means of personal interviews using structured questionnaires. The questionnaires were administered in equal proportions in Funtua and Malumfashi in Katsina State, Gusau in Sokoto State, Zaria in Kaduna State and Gombe in Bauchi State. These states constituted the bulk of the cotton producing areas in the country; accounting for between 60 - 70% of the nation's total output of cotton. Consequently they were expected to experience very high level of marketing activities in respect of the produce. Data were collected from farmers on such marketing activities as storage, marketing costs, modalities of sales and their experiences and assessment of the new marketing system, and prices realised. The data collected from merchants included volume of purchase, costs of operations, and processing activities. Similar information were collected from the buying agents and cotton ginners.

The data collected were analysed using marketing margin analysis and three measures of market structure analysis - the Gini Coefficient, the Herfindahl Index, and the Coefficient of variability. The marketing margin gives the proportion of the consumer's expenditure on a commodity that is received by the producer and each of the marketing intermediaries. It is a useful indicator of marketing efficiency as it allows for comparison between the earnings of each market participant relative to his cost of providing a service.

Expressed as a percentage, the formula for computing marketing margin is:

$$M = \frac{P_1 - P_2}{P_2} \times 100 \quad ....(1)$$

Where: M = percentage margin,

P_1 = Selling price, and

P_2 = Supply price.

The models for the three measures of size distribution are represented as follows:

(1) Gini Coefficient (G):

$$G = (\tfrac{1}{2} n^2 u) \sum_{i=1}^{n} \sum_{j=1}^{n} [Yi - Yj] \quad ...(2)$$

Where:

G = value of the Gini Coefficient to be determined,
n = number of observations,
u = arithmetic mean of observations,
Yi = purchases/output of obser vation i, and
Yj = purchases/output of observation j,

The Gini Coefficient (G) has a possibility of values ranging from 0 to 1 expressing the extent to

which the market is concentrated. The value of G equals to 0 when there is perfect equality in the size distribution of buyers or sellers, as the case maybe. The G equals to 1 when there is pure monopoly in the market.

(ii) The Herfindanl Index (H):

$$H = \sum_{i=1}^{n} \left[\frac{Xi^2}{X}\right] \quad \ldots(3)$$

Where:

H = the value of the Herfindahl index to be determined,
Xi = volume of purchases/output of the i^{th} market partici pant
X = total purchases/output in the sample; and
n = total number of observations.

The Herfindahl Index (H) represents the sum of the squared ratios of purcahse/output of each individual participant to the total purchases/output of all participants in the sample. The highest possible value for H is 1 where the market is perfectly concentrated and the lowest possible value is 1/n when the size distribution of the sampled participants are equal.

(iii) Coefficient of Variability (C):

$$C = \left(\frac{V^2}{U}\right)\left(\frac{V^2}{U} + 1\right)^{-1} \quad \ldots(4)$$

Where:

C = standardised value of the Coefficient of Variability to be estimated,
v = standard deviation of the distribution, and
u = arithmetic mean of the observations.

The Coefficient of Variability gives the extent to which a set of values are dispersed about their mean. The standardised measure of the Coefficient of variability (C) represented by the above model equals to 0 when there is perfect equality in the size distributions of data and approaches unity, the greater the level of concentration. For all the three models, the closer the values obtained are to 1, the greater the monopolistic tendencies in the distribution which implies the greater the power of one or few individuals in influencing prices and, therefore, the less the efficiency of the market. On the other hand, the lower the values obtained the greater the quality in competition and thus the less the power of a few to influence prices. Such a market will therefore be more efficient.

As a measure of size distribution, the H tends to be more accurate as the size of data increases. Similarly, the C is found to be most sensitive in discriminating distribution with extreme inequality in the high range of values while G is particularly sensitive to inequalities in the middle range of the distributions (Olukosi, 1982).

RESULTS AND DISCUSSIONS

(1) The organisation of the market and the role of the cotton merchants.

Buying and selling of seed cotton were scheduled to be conducted at gazetted cotton markets. The government retained its responsibility for erecting and maintaining the markets in all cotton producing areas of the country where farmers were required to take produce for sale to private buyers after inspection and grading. This study however showed that farmer sold their cotton either at home or at the farm gates. Seventy eight percent (78%) of the sampled farmers said they sold their produce at home, while none of them was found to have sold at any of the gazetted markets.

For this reason, inspection and grading were never carried out. This had implications for quality but the buying agents were very experienced in assessing the quality of the commodity and hence prices offered. Most of the buying were done by commisioned agents who were employed by merchants to go from village to village to purchase seed cotton. The previous marketing board restrictions on time and place of buying and selling of cotton appeared to be non-existent under the present arrangement. Buyers and sellers entered into contract at any convenient location.

Cotton merchants supplied the funds for performance of marketing services and bore the responsibility of organising and supervising the execution of the services. The merchants were the only participants in the marketing system who took title to the produce. They were, therefore, the highest risk-bearers. All other participants handled the produce on behalf of the merchants. Merchants were also found to be important sources of input for farmers especially seeds and credit in cash. Of the 75 farmers sampled, 21 of them used credit to finance

their production and 16 of these borrowed from merchants.

Cotton processing, on the other hand, was done by cotton ginning companies spread all over the cotton producing areas in the country. Since 1986, at least seven new ginneries have been established in addition to the former 13 bringing the total number of ginneries in the country to 20. These are owned by 7 private companies and two states. The Zazzau and Challawa ginneries are owned by Kaduna and Kano States respectively.

(ii) The Market Structure

The most important element of market structure that determines competitive relations among buyers and sellers as well as pricing is the size distribution of the buyers and sellers (Aboyade, 1983). Prior to the 1986 deregulation, the cotton market was a pure monopsony with the Nigerian Cotton Board as the only buyer.

The three measures of size distribution discussed above were used to determine the level of concentration among sellers on the basis of individual output, and of buyers (merchants and commision agents) based on their individual volume of purchases. The values obtained from the three models are shown in Table 1 for farmers, merchants and buying agents. The standardised values of the coefficient of variability are given along with their absolute values which are in parentheses. The lowest values expected for the H values (which is 1/n) equals to 0.0833, 0.0667 and 0.0133 for the merchants, the buying agents and the farmers respectively.

The results showed certain degree of concentration among buyers, particularly the merchants. Much of the concentration was explained by inequalities in the middle and high range of the distribution as shown by the high values of C. The degree of concentration was lower among the buying agents. As for sellers, the results indicated a high level of equality in their distribution. The C, however, indicated much greater degree of inequality among farmers than among buying agents.

The results show that the level of concentration was highest among buyers, implying that a major proportion of the purchases in the market was accounted for by a few firms. The level of concentration, however, did not appear to be high enough as to suggest an oligopsonistic situation as compared to what obtained before the deregulation.

The higher indication of concentration among the buyers (merchants) is not unexpected since barriers to entry, as measured in terms of costs, is higher among merchants than among agents or sellers. This is so because the level of investment required to establish a cotton-buying firm is much higher than that required to go into cotton production or that of becoming a buying agent.

Grading of cotton before sales appeared to have been largely abandoned under the present marketing arrangement. However, buyers and sellers relied on their subjective assessment, and knowledge of the product to determine quality and hence prices. At the ginners' level, there were variations in packaging, but this did not appear to affect prices much.

Vertical integration was also observed to be developing gradually among the market participants, with the textile mills going into ginning and direct production of seed cotton; cotton producers going into buying activities; and merchants going into ginning.

This will enhance profitability for the market participants through collective use of resources. It could, however, also shift the market towards oligopoly situation should the integrating firms acquire greater power as to block entry or influence prices.

Finally, there was free flow of price and other market information among the market participants. All the respondents interviewed indicated that they had prior knowledge of the prevailing prices before they either bought or sold their seed cotton. They said that they usually got informed of price changes within a few days of such changes.

From the foregoing, it was concluded that the present structure of the cotton market is free and highly competitive.

(iii) Marketing margin

The marketing margin earned by a cotton farmer was estimated to be 71.53 percent of what the textile firms paid for ginned cotton lint in 1992. The details of the margins earned by the various categories of market participants are given in Table 2. This scenario was viewed as representing a tremendous improvement on the farmer's share of the final price paid for his produce and was symptomatic of an efficient marketing system.

Similarly, the cost incurred by a farmer in marketing his produce was estimated to be 4 percent of the total cost of production. This indicated a more favourable mar-

keting arrangement compared with the 25 percent incurred under the previous Commodity Marketing Board System (Isitor, 1985).

Furthermore, the continued increases in the volume of seed cotton produced is seen as an evidence of farmer's satisfaction with the current marketing arrangement and the higher prices being paid for their produce. For instance, between 1986 and 1992, prices of seed cotton increased by 547 percent (Tables 3 and 4). Increase in product prices did not translate automatically into equivalent high profits due to increases in costs arising from input price increases. Cotton farmers, however, still enjoyed some enhanced levels of profits because the increases output prices outweighed the increases in input prices. This implied that the system has, thus far, favoured cotton farmers.

It can, thus, be argued that the present marketing system has performed efficiently in terms of distributing costs and benefits among the various market participants.

CONCLUSION

The results of this study showed that farmers have been getting better prices for their produce, and a number of obstacles hitherto encountered in the marketing of cotton have been removed under the new marketing arrangements.

Even though prices of inputs have also increased, higher rate of increase in produce prices has ensured that farmers continued to make profit. In response to this incentive, output of cotton is gradually regaining its past glories.

It has also been observed that members of the private sector have taken up the challenge by effectively organising the marketing of cotton. Similarly, the market structure analyses have shown that the Nigerian cotton market is very competitive.

One area of setback under the new system is quality control. Lack of inspection and grading leaves room for adulteration of seed cotton especially the practice of wetting the produce in order to increase its weight. Such practice causes the seed to lose its quality resulting in poor germination when planted. Government should as a matter of urgency, liaise with merchants in order to restore inspection, so that quality control is maintained.

Even though prices of seed cotton have been increasing significantly, the increases in output as well as importation of cotton lint from neighbouring countries will likely force prices down in the very near future. For this reaseon, measures should be taken to ensure effective supply of farm inputs to farmers at controlled prices, so that their cost of production could be decreased. At the rate the cost of inputs are increasing, any down-turn in the level of product prices will result in colossal losses for the farmers. Such an incidence could distract them away from cotton production and the benefits of the deregulation policy will them be defeated.

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Table 1: Measures of size distribution of market participants.

Participant	Herfindahl Index	Gini Coefficient	Coefficient of Variation
Merchants	0.3251	0.5915	0.7599 (1.779)
Agents	0.0983	0.03551	0.3372 (0.7133)
Farmers (Sellers)	0.0318	0.02335	0.5423 (1.185)

Source: Field Survey, 1992.

Table 2: Marketing margins for various participants in seed cotton marketing.

Participant	% of Marketing Margin Earned
Commissioned Agents	3.97
Merchants	14.61
Cotton Ginners	7.28
Transporters	2.61
Total	28.47
Producer's Share	71.53

Source: Field Survey, 1992.

Table 3: Price relatives for cotton 1986-1992

Year	Price (₦/tonne)	Price Relatives
1986	850	100
1987	2,000	235
1988	3,000	353
1989	3,500	412
1990	4,000	471
1991	5,000	588
1992	5,500	647

Source: Field Survey, 1992.

Table 4: Cotton production (lint) and estimated demand in Nigeria, 1982 - 1992 (Tonnes).

Year	Production	Estimated demand
1982	21,591	85,099
1983	19,926	108,063
1984	11,700	112,214
1985	14,418	115,824
1986	9,379	119,847
1987	24,075	124,098
1988	28,268	128,271
1989	37,497	131,876
1990	31,261	137,390
1991	26,033	142,031

Source: Field Survey, 1992

EFFECT OF TILLAGE AND CROP RESIDUE MANAGEMENT ON MAIZE GROWN ON ALFISOL IN SAVANNA ZONE

E.N.O. IWUAFOR[1] and B.T. KANG[2]

SUMMARY

The effects of tillage and crop residue management systems on growth and grain yield of maize (*Zea mays* L.) was investigated for three cropping seasons on an Alfisol at two sites of central Nigeria. At Mokwa the plot was previously cropped and fallowed for two years and at Bida the plot was newly cleared from woody vegetation. Four tillage methods, (no tillage (Tn), strip tillage (Ts), manual tillage (Tm) and conventional tillage (plough and harrow) (Tc) as main plots, and three residue management methods (mulch, remove and burn) as subplots were compared using a split-plot design with four replications.

At Mokwa seedling emergence and plant heights were lower with no tillage. At Bida no tillage showed lower seedling emergence in the first year only. Root density was higher in the surface soil (0-10 cm) with no tillage (Tn) and in the deeper layers (10-20; 20-30 cm) with conventional tillage (Tc). Mulching resulted in higher root density in the surface soil (0-10 cm). At both locations, tillage (Tm and Tc) gave higher mean maize yield than reduced tillage (Tn and Ts) over the three seasons. Crop residue management improved maize yield at Mokwa in the following order; mulch > burn > remove. Residue management had no effect on maize yield at Bida. A significant interaction occurred between tillage and residue management at Mokwa. Conventional tillage (Tc) with all residue management methods outyielded other tillage treatments. The better maize growth and yield with conventional tillage (Tc) compared to no tillage (Tn) particularly at Mokwa may be attributed to lesser weed problem and deeper root system.

Keywords: Alfisol, maize, residue management, tillage.

RESUME

L'effet du travail du sol et des systèmes de gestion des déchets de culture sur la croissance et le rendement/grains du maïs (*Zea mays* L.) a été étudié sur alfisol durant trois saisons culturales. L'étude a été conduite sur deux sites localisés dans le centre-ouest du Nigéria. A Mokwa, la parcelle avait été au préalable cultivée et laissée en jachère pendant deux ans. Quant à Bida, on a utilisé une parcelle qui venait d'être débarrassée d'une végétation ligneuse. On a comparé au moyen d'un dispositif en split plot à quatre répétitions, quatre modes de travail servant de parcelles principales : non labour (Tn), labour en bandes (Ts), labour manuel (Tm) et labour en planche (charrue et herse) (Tc) et trois méthodes de gestion des déchets de culture, utilisées comme pacelles secondaires (mulch, enlèvement, incinération).

A Mokwa, la levée des plantules et les hauteurs de plante étaient inférieures en système de non labour tandis qu'à Bida, le non labour a présenté un faible taux de levée seulement en première année. L'application du mulch a entraîné une augmentation de la densité racinaire dans la couche supercielle (0-10 cm). Dans les deux localités, le labour (Tm et Tc) a donné des rendements moyens en maïs plus élevés que ceux du travail réduit (Tn et Ts) pendant toutes les trois saisons. La gestion des déchets végétaux a amélioré le rendement du maïs à Mokwa dans l'ordre suivant; mulch > incinération > enlèvement. La gestion des déchets n'a pas eu d'effet sur le rendement du maïs à Bida. Le labour en planche (Tc) ajouté à toutes les méthodes de gestion de résidus de culture a permis des rendements supérieurs à ceux des autres labours. L'amélioration de la croissance et du rendement du maïs en système de labour en planche (Tc) peut être attribuée à la faible importance des problèmes d'adventices ainsi qu'à un système racinaire profond.

Mots Clés : Alfisol, maïs, gestion des déchets de culture, labour.

INTRODUCTION

Different tillage and residue management systems are used in traditional farming systems in the Guinea savanna zone of West Africa. Land preparation is mainly done manually using the hoe and to a limited extent by ox-drawn implements. The use of tractor-drawn implements is limited by availability and high cost. It is, however, used in large scale mechanised farms. To facilitate land preparation by any of these methods, crop and plant residues are usually cleared from the field through burning. Removal of crop residue for revenue generating prurposes is also commonly practiced. The zero/minimum tillage sys-

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tems have been tried and showed some promising results in the Nigerian savanna (Ike, 1985).

Different tillage and crop residue management systems are known to affect soil properties. The trends and magnitude of their effects are known to vary among soils and ecological regions. Some effects of methods of seed bed preparation are transient, while others are long lasting. Luthrell and Lovely (1964) reported that ploughing reduced soil bulk density. No tillage with residue mulching has been shown to increase soil moisture retention and infiltration and to lower soil temperature (Black, 1973; Lal, 1979 and Ike, 1985). Higher concentrations of organic C, total N, extractable P, exchangeable Ca, Mg, and K have been shown in surface soil of no till than tilled plots (Blevins *et al.,* 1983; Hargrove *et al.*, 1982, Dick, 1983). These benefits from no tillage are attributed to the residue mulch.

These altered soil properties also affect crop performance and yield. Beneficial effects of mulch on crop yields have been demonstrated by various workers (Okigbo, 1969, Lal, 1975; Aina, 1979). Doran *et al.*(1984) reported that crop residue removal reduced maize and soyabean yields by 22 and 24% respectively. Lal and Kang (1982) noted yield reduction in maize and particularly cowpea with annual removal of maize yield in unmulched than in mulched plots. Despite some disadvantages of burning, yield increases have also been reported with this practice (Biederbeck *et al.*, 1980). The objective of this study was, to investigate the effects of tillage and crop residue management methods on performance of maize grown on an Alfisol in southern Guinea savanna of Nigeria.

MATERIALS AND METHODS

The investigations were conducted from 1982-1984 at two locations; (1) at the Bida Agricultural Development Project farm at Bida junction, and (2) at the Institute for Agricultural Research,Ahmadu Bello University experimental farm at Mokwa. Both experiment sites are located around Mokwa located in the southern Guinea savanna zone of central Nigeria at about 9.31°N and 5.04°E. The climate, geology and the surface soil characteristics of the experimental sites are shown in Table 1. At Bida junction, the experiment was located on land newly cleared from wooded fallow vegetation, while at Mokwa the land was under fallow for 2 years after being used for vegetable and groundnut trials. Topography of both sites were relatively flat.

The experimental design used was a split plot with four replications. Four tillage treatments made up the main plots and three crop residue management treatments were the subplots (Table 2). Land preparation and residue management operations were done each season. Sub-plot size was 8 x 5 m. Maize (var. TZPB) was planted manually as the test crop at both locations. Plots received fertilizer at the rate of 120 N - 26 P - 50 K in kg/ha. One third of N (as calcium ammonium nitrate), all of P (as single superphosphate) and K (as muriate of potash) were surface broadcast as basal dressing before planting. The remaining N was applied at 4 weeks after planting (WAP) by band application. Three maize seeds were planted per hill at 75 cm inter and 25 cm intra-row spacing. In 1982, 5 t ha^{-1} of dry maize stover was applied to mulch and burn treatment plots (Table 2). No external crop residue was applied in subsequent years. In treatment with crop residue removal, plant residue was removed from plots after each crop harvest and the plots kept bare.

Two weeks after emergence, maize plants were thinned to one plant/hill, giving a plant population of 53,300 plants/ha. Weeds in Tc and Tm treaments were controlled manually by hoe-weeding. In Tn and Ts plots, weeds were sprayed before planting with paraquat (1-1-dimethyl 4, 4-bipyridynium) at a rate of 1.0 kg a.i. per ha. Subsequent slashing of weeds was done manually when necessary.

Seedling emergence counts were done at 10 days after planting (ADP) and computed as percent of number of seeds planted. Maize plant height was measured at 2 weekly intervals in 1984 from fifteen plants per plot. Root measurements were done in 1984. At silking time of maize, root samples were taken from three plants per plot, by excavating soil blocks of 10 x 10 cm size at lateral distances of 0-10, 10 - 20 and 20 - 30 cm from each of the plants and at vertical depths of 0 - 10, 10, 10 - 20 and 20 - 30 cm. Each of these soil blocks were placed on a sieve and roots carefully washed. Root remaining were oven dried at 65°C and weighed. Weed densities were estimated yearly by scoring, using a scale of 0 (low) and 5 (high) at 30 DAP. Grain yields were measured at maturity and reported at 12% moisture content.

RESULTS AND DISCUSSIONS

Seedling emergence

At Mokwa, emergence was significantly lower with no tillage (Tn) compared to other treatments for the three years (Fig.1). Emergence at Bida junction in 1982 was significantly higher with strip tillage (Ts) and conventional tillage (Tc) treatments than with no tillage (Tn), while in 1983 and 1984 differences were not significant (Fig. 1). The lower emergence under no tillage (Tn) was due to shallow planting depth, as planting was observed to be more difficult in these plots due to high soil bulk density (Table 1). Seed/soil contact, may be less favourable with Tn, to enhance germination and emergence. Such shallow seeding also results in easy removal of seeds by rodents and birds. The lack of any significant difference between Tc, Tm and Ts treatments indicates that intensive soil disturbance as done with conventional tillage (Tc) does not give any appreciable benefit on seedling emergence. Differences in emergence between the locations may be due to differences in soil moisture at time of sowing.

At both locations, crop residue management methods did not significantly affect emergence.

Plant height

Maize plant height measurement done at Mokwa in 1984 is shown in Fig. 2. At all growth stages, plant height was significantly higher with conventional tillage (Tc) than with other tillage treatments, this may be due to higher weed density under Ts and Tn treatments (Table 3), resulting in increased moisture and nutrient competitions with the crops. At Bida junction there was no effect of tillage treatments on maize plant height. Crop residue management treatments also did not significantly affect plant height at both locations.

Root growth

Irrespective of tillage and residue management methods, the majority of the roots were found to be concentrated at 0-10 cm depth at all lateral sampling distances from the maize plant. Comparing the different tillage treatments, higher root density was observed at 0-10 cm depth under no tillage (Tn), than under Tc and Tm (Figs 3 and 4). Baeumer and Bakermans(1973) also noted higher root densities in surface soil with no tillage,due to higher moisture and nutrient concentrations. At lower depth of 10-20 cm and 20-30 cm root concentrations were generally higher with conventional tillage (Tc) than with Tn or Tm treatments. The loosening of the soil with conventional tillage appears to favour root growth at lower depths.

Irrespective of tillage methods, root densities were also higher in the surface (0-10 cm) layer in mulch plots, than in plots with residue burn or remove. Jacks *et al.* (1985) also showed that plant roots tend to accumulate at or near the soil surface with presence of mulch material.

Weed infestation

At Mokwa for the three cropping seasons, weed density was significantly lower with conventional (Tc) and manual (Tm) tillage than with Ts and Tn (Table 3). At Bida junction in 1982 and 1983 tillage treatments did not affect weed infestation, while 1984 weed density was significantly higher with Tn than the other tillage treatments. The mean weed scores for both locations showed significantly lower weed densities with Tc and Tm treatments, which signifies the important role tillage plays in weed control. Ike (1985) also observed significantly higher weed population with no tillage than with mechanical tillage.

Removal of crop residue increased weed density at both locations for the three cropping seasons (Table 3). The mean values over the seasons showed that weed growth was significantly lower with either mulching or burning at the two locations. Lal (1975) also reported that mulching which provided adequate soil cover is effective in suppressing weeds.

Maize yield

The effect of different tillage and residue management methods on maize grain yield at both locations is shown in Table 4. At Mokwa for the three seasons, conventional tillage (Tc) gave the highest yield followed by manual tillage (Tm) and strip tillage (Ts). No tillage (Tn) gave the lowest yield.

At Bida junction the effect of tillage on maize grain yield for the three seasons was not as pronounced as at Mokwa site. In 1982 maize yield with conventional tillage (Tc) was significantly higher than with other tillage treatments (Table 4). Despite the absence of significant yield differences in 1983 and 1984, the highest yield was also observed with Tc in both years. The mean yield for the three seasons also showed the same

trend with Tc giving the highest yield followed by Tm, Tn, and Ts treatments.

At Mokwa for the three cropping seasons mulching and crop residue burning gave higher maize yield than with crop residue removal (Table 4). The plot with crop residue removed showed significantly lower yield than with mulch and burn plots in 1982 and 1983 and significantly lower yield with mulch plot in 1984. The beneficial effects of crop residue mulching have been demonstrated for Alfisols (Lal, 1975; Maurya and Lal, 1981) and on Ultisols (Okigbo, 1989). The three seasons mean yield also showed a significant difference between mulching and residue removal treatments. At Bida junction, crop residue management for the three cropping seasons did not show any effect on maize yield.

The second order interaction between tillage and residue management method was significant at Mokwa site in 1983 (Table 5). The result showed that for the four tillage treatments the practice of mulching gave higher yield than the other residue management systems. The interaction effect confirms that for no tillage practice to be effective, adequate residue mulching is very important.

Comparing the effects of tillage and residue management systems on maize yield at both locations, it appeared that more pronounced effects were observed at the cropped land at Mokwa site than on the newly cleared land at Bida junction. Kang and Messan (1983) also reported no significant effect of tillage on newly cleared land. As shown in Table 3, tillage (Tc and Tm) significantly reduced weed density at Mokwa while at Bida junction significant effects of tillage (Tc and Tm) in reducing weed density was only observed in the third cropping year. The lower maize yield at Mokwa with reduced tillage (Tn and Ts) can be attributed to the higher weed density (Tables 3) which may compete with the crops for moisture and nutrients. Nangju (1979) also reported lower cowpea and soyabean yields with no tillage, which was attributed to more weed infestation and lower fertilizer use efficiency. Addition of crop residue either as mulch or by burning may also contribute nutrients to the crop.

CONCLUSION

Relationship between tillage and residue management systems on performance of maize was less apparent on newly cleared land at Bida junction and more pronounced on cropped land at Mokwa. The effect of crop residue management on weed infestation and maize yield followed the same pattern as the effect of tillage at both locations. Mulching and residue burning which significantly reduced weed infestation gave higher maize yield than residue removal at Mokwa site. At Bida junction where the effect of residue mulching and burning on weed infestation is less apparent, there was no significant effect of crop residue management on maize yield.

At both locations the higher maize yield observed with conventional tillage could be attributed to deeper root system enabling the plants to explore larger soil volume for nutrients and water combined with lesser weed problem, and probably also due to lower nutrient and moisture competition with the crops.

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Table 1. Rainfall, geology and soil characteristics of the experimental sites.

Parameter	Mokwa	Bida junction
Mean total annual precipitation (mm)	1055	1055
Geology	Nupe sandstone	Nupe sandstone
Soil classificaton	Oxic paleustalf	Oxic Paleustalf
Soil characteristics (0-15 cm)		
Organic C (g kg^{-1})	5.9	6.1
pH (1:1 in H_2O)	6.0	5.9
Bray P-1 (mg kg^{-1})	11.9	8.5
Exchangeable Ca (cmol kg^{-1})	1.24	2.48
Exchangeable Mg (cmol kg^{-1})	0.24	0.51
Exchangeable K (cmol kg^{-1})	0.13	0.17
Total N (g kg^{-1})	0.37	0.39
C:N ratio	16.0	15.6
Sand (g kg^{-1})	820	850
Silt (g kg^{-1})	120	80
Clay (g kg^{-1})	60	70
Bulk density (Mg m^{-3})	1.47	1.42

Table 2. Tillage and residue management treatments.

Treatments	Seedbed preparation methods	Approximate depth of soil disturbance (cm)
Tillage (main plots)		
No-tillage (Tn)	No disturbance of soil surface	
Strip tillage (Ts)	No disturbance of soil except for 15 cm tilled strips spaced 75 cm apart made by tilling with a hoe	15.0
Manual tillage (Tm)	Plots were tilled with a hoe	15.0
Conventional tillage tillage (Tc)	Plots were disc ploughed once, and disc harrowed twice	23.5
Residue management (subplots)		
Mulch	Plant residue were spread evenly after land preparation and planting	
Burn	Plant residues were spread evenly and burnt before land preparation	
Remove	Plant residues were removed before land preparation	

Table 3. Mean effect of tillage and residue management treatments on weed scores+

Treatments	1982	1983	1984	Mean
		Mokwa		
Tillage				
Strip tillage (Ts)	1.51 a++	1.45 a	1.61 a	1.52 a
Conventional tillage (Tc)	0.73 b	0.97 b	1.30 b	1.00 b
No tillage (Tn)	1.48 a	1.21 a	1.61 a	1.43 a
Manual tillage (Tm)	0.88 b	0.86 b	1.24 b	0.99 b
Residue				
Mulch	1.05	1.09 b	1.36	1.17 b
Remove	1.35	1.24 a	1.59	1.39 a
Burn	1.05	1.04 b	1.36	1.15 b
		Bida junction		
Tillage				
Strip tillage (Ts)	0.64	1.03	1.34 b	1.00 a
Conventional tillage (Tc)	0.56	0.80	1.23 b	0.86 b
No tillage (Tn)	0.64	1.06	1.50 a	1.07 a
Manual tillage (Tm)	0.52	0.94	1.25 b	0.90 b
Residue				
Mulch	0.53 b	1.00	1.22 b	0.95 b
Remove	0.70 a	1.01	1.45 a	1.05 a
Burn	0.54 b	0.89	1.33 b	0.92 b

+ Weed density was scored on a scale of zero (low) to 5 (high)

++ For each site, values for tillage or residue treatments within the same column followed by no or the same letter are not singificantly different at P = 0.05 according to Duncan's multiple range test.

Table 4. Mean effect of tillage and residue management treatments on maize grain yield (t ha^{-1})

Treatments	1982	1983	1984	Mean
		Mokwa		
Tillage				
Strip tillage (Ts)	3.38 b+	3.72 b	2.99 b	3.36 b
Conventional tillage (Tc)	4.24 a	4.92 a	4.28 a	4.44 a
No tillage (Tn)	3.30 b	3.42 b	2.94 b	3.29 b
Manual tillage (Tm)	3.84 a	4.29 a	4.21 a	4.11 a
Residue				
Mulch	3.62 a	4.47 a	4.16 a	4.08 a
Remove	3.54 b	3.66 b	3.09 b	3.43 b
Burn	3.84 a	4.12 a	3.56 ab	3.84 ab
		Bida Junction		
Tillage				
Strip tillage (Ts)	2.95 b	3.32	3.66	3.31 b
Conventional tillage (Tc)	3.94 a	3.59	3.99	3.84 a
No tillage (Tn)	3.40 b	3.35	3.49	3.41 b
Manual tillage (Tm)	3.37 b	3.40	3.77	3.51 ab
Residue				
Mulch	3.17	3.54	3.58	3.43
Remove	3.45	3.23	3.72	3.47
Burn	3.62	3.47	3.88	3.66

+ For each site values for tillage or residue treatments within same column followed by no or the same letter are not significantly different at P = 0.05 according to Duncan's multiple range test.

Table 5. Interaction between tillage and residue management treatments on maize grain yield (t ha^{-1}) at Mokwa in 1983.

Tillage treatments	Residue treatments		
	Mulch	Remove	Burn
Strip tillage (Ts)	4.33	2.48	4.34
Conventional tillage (Tc)	5.21	4.67	4.87
No tillage (Tn)	3.84	3.47	2.94
Manual tillage (Tm)	4.51	4.03	4.31

LSD.05 Between residue treatments for same tillage treatments, 0.86;
Between residue treatments for different tillage treatments, 0.83

Figure 1. Effect of tillage on maize seedling emergence at Mokwa and Bida junction (Treatments: Tn = no tillage; TS = strip tillage; Tm = manual tillage; TC = conventional tillage).

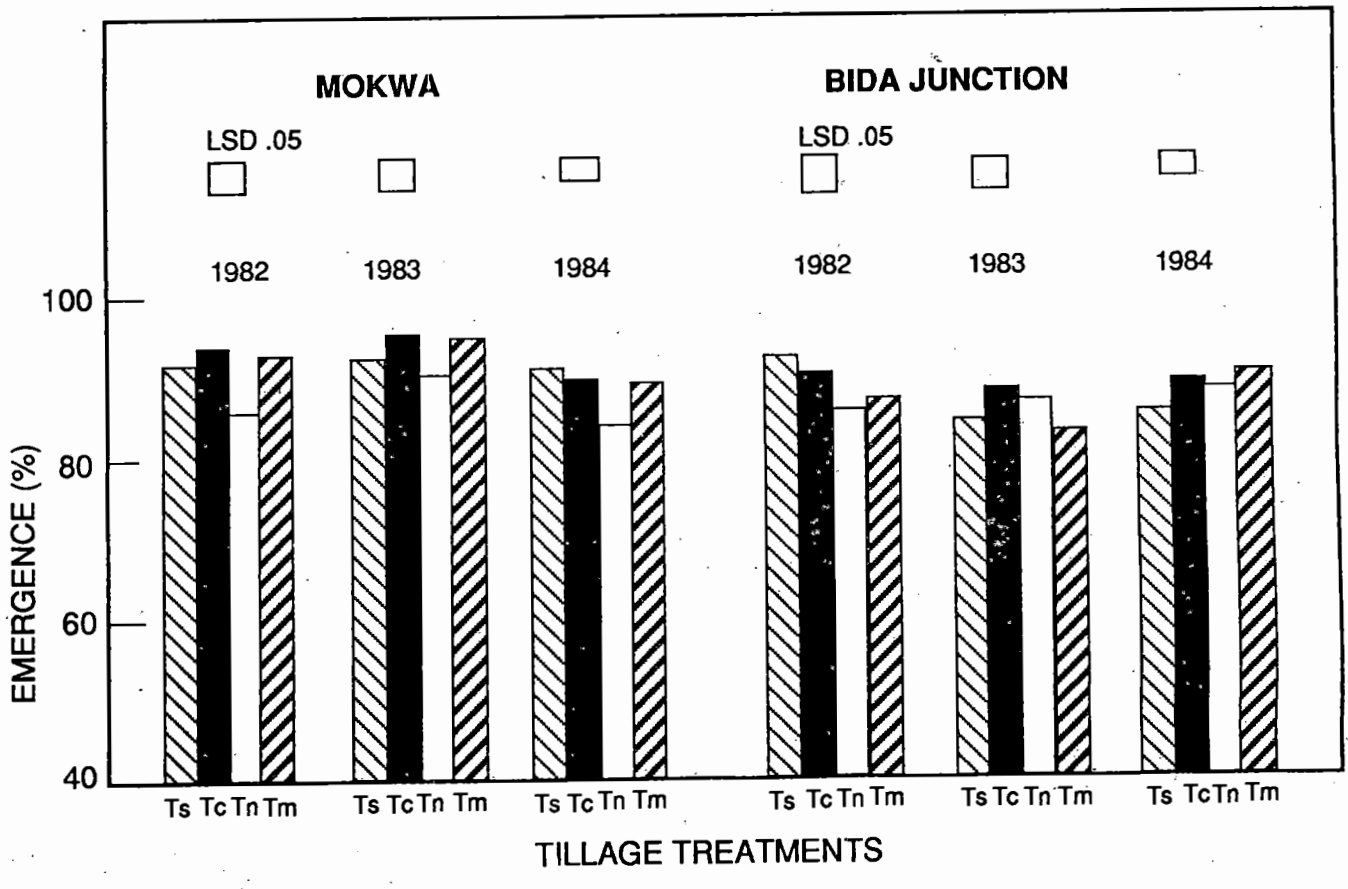


Figure 2. Effect of tillage on maize plant height at Mokwa measured in 1984 (Treatments; Tn = no tillage: Ts = strip tillage; Tm = manual tillage; Tc = conventional tillage).

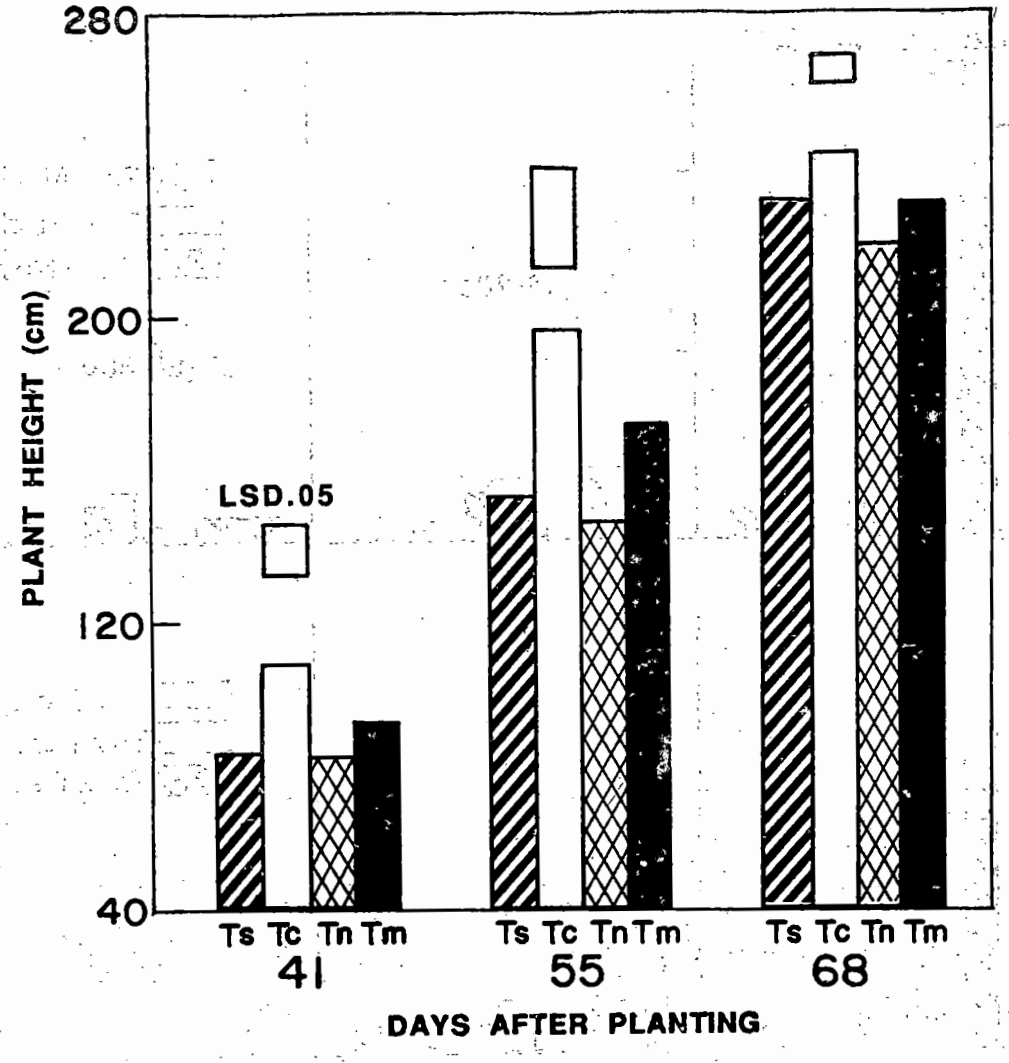


Figure 3. Effect of tillage and crop residue management on root density at Mokwa site in 1984 (Tillage treatments; Tn = no tillage; Tm = manual tillage and Tc = conventional tillage).

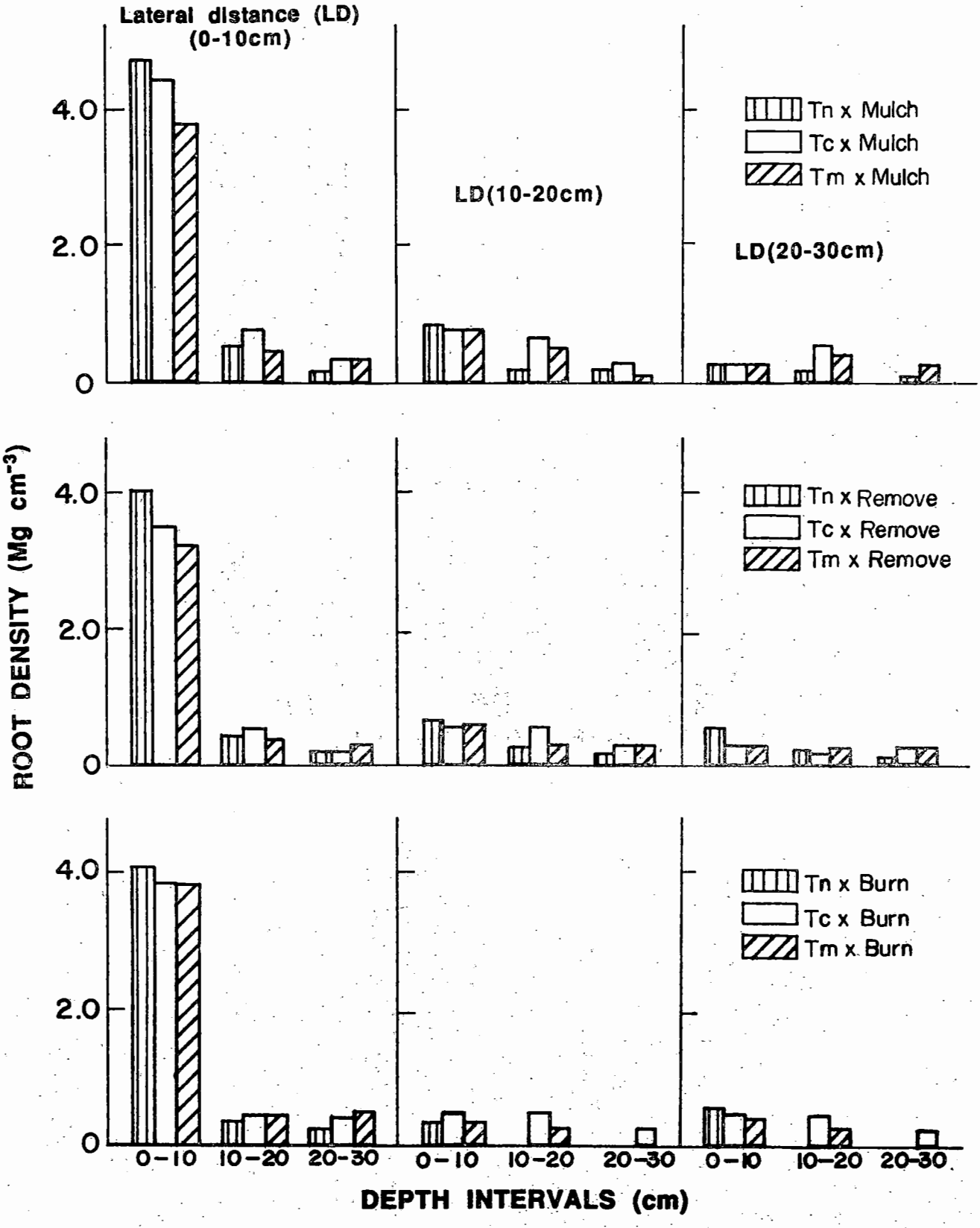
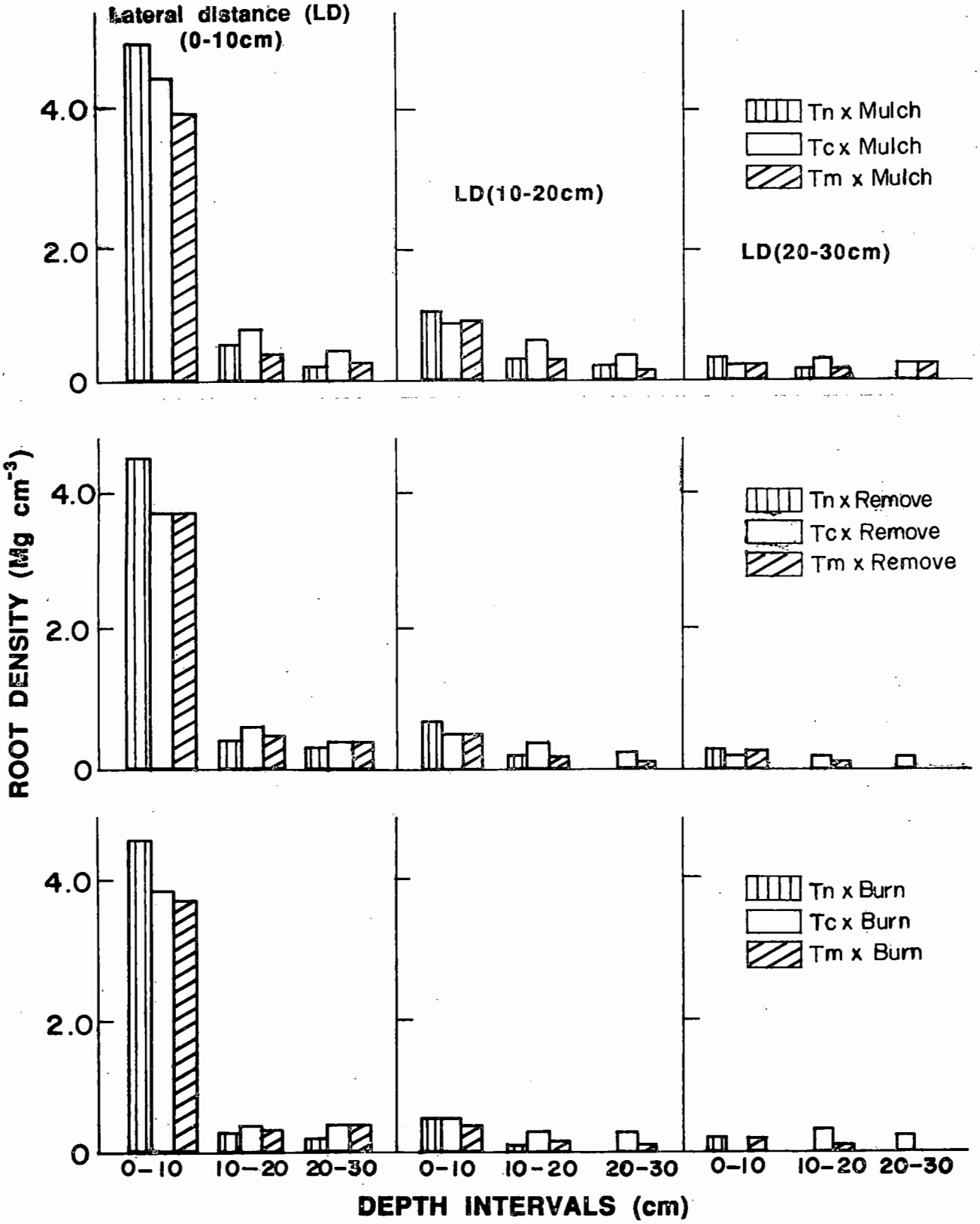


Figure 4. Effect of tillage and crop residue management on root density at Bida junction site in 1984 (Tillage treatments; Tn = no tillage; Tm = manual tillage and Tc = conventional tillage).



MODES D'ACCES A LA TERRE ET EFFICACITE DES EXPLOITATIONS AGRICOLES DANS LA ZONE OUEST DU BURKINA FASO

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RESUME

L'objectif de cet article est de déterminer les modes d'accès à la terre qui affectent l'efficacité des exploitations agricoles dans l'Ouest du Burkina Faso. Pour cela, nous avons utilisé les marges brutes au lieu de la productivité physique à l'hectare. En effet, la marge brute atténue les distorsions dues aux écarts qui peuvent intervenir centre les montants du capital variable utilisé dans le processus de production. Etant donné les fonctions assumées par les différentes cultures, la comparaison a été effectuée à trois niveaux : marge brute des cultures vivrières, marge brute de la principale culture de rente (le coton) et marge brute globale de l'exploitation. Les informations ont été collectées dans deux villages de l'Ouest du Burkina, Séguéré et Djigouéma, pendant la campagne agricole 1989-1990.

Les résultats de l'analyse montrent que dans le village de Djigouéma, où la pression foncière est très forte, l'efficacité des exploitations varie suivant le mode d'accès à la terre. Par contre, à Séguéré où la crise foncière n'est pas très aiguë, le mode d'accès à la terre n'influence pas l'efficacité des exploitations.

Mots clés: Modes d'accès à la terre, efficacité des exploitations agricoles, marge brute.

SUMMARY

The objective of this study is to determine the types of access to land that affect farm efficiency in the West of Burkina Faso. For that purpose the comparison criteria used is the gross revenue instead of the physical productivity per hectare because it has the advantage of reducing the distortions due to various amounts of capital used by the farmers in the production process. The comparison of efficiency has been undertaken at three different levels: gross revenue of food crops, gross revenue of the main cash crop (cotton) and global gross revenue of the farm. The relevant data were collected within two villages in western Burkina Faso, namely Séguéré and Djigouéma during the growing season of 1989-1990.

The results show that in Djigouéma where the pressure on land is very high, the farm efficiency varies according to the land tenure system. But in Séguéré where the access to land is not such a big problem, the modes of access to land do not influence the farm efficiency.

Keywords: Modes of access to land, farm efficiency, gross revenue.

INTRODUCTION

Les sécheresses successives qui ont frappé la région sahélienne ces dernières années ont conduit de nombreux agriculteurs à migrer vers des régions mieux arrosées. Au Burkina Faso, cette migration s'est faite du Nord à l'Ouest et au Sud-Ouest. Dans cette partie du pays où les conditions climatiques et édaphiques sont favorables à l'agriculture, l'occupation des terres par les migrants a obéi à l'un des principes du système foncier traditionnel. Ce principe faisait que tout homme, qu'il soit membre de la communauté villageoise, ou étranger avait droit à une portion de terre pour ses besoins de subsistance. Les migrants n'avaient donc pas éprouvé de difficulté pour accéder à la terre et pratiquaient alors une agriculture extensive et consommatrice d'espace (Ancey, 1973 ; Boutilier et al, 1977). Avec l'accroissement de la population dû à l'afflux des migrants, les potentialités agricoles de la région se sont réduites entraînant un changement dans le comportement des populations autochtones vis-à-vis de la terre. Les conditions d'accès à la terre étant devenues plus rigoureuses, le droit naturel à la terre a été progressivement remplacé par des contrats tacites qui lient le propriétaire et l'occupant de la terre. Ces contrats n'offrent souvent que des droits d'usage précaires qui se traduisent par différentes modalités de tenure de la terre. L'exploitant qui ne maîtrise pas le statut foncier de la terre qu'il cultive ne sera pas disposé à y investir. Par ailleurs, en Asie et en Amérique latine, des chercheurs ont montré que les mo-

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des de tenure des terres influençaient les systèmes de production, notamment l'allocation des ressources. C'est le cas de Junankar (1980) au Penjab (Inde), Shanhidur et al (1987) au Bangladesh et Gershon (1987) en Thaïlande. En Afrique, Shem et al (1991) dans le cadre du Ghana, du kenya et du Rwanda ont montré que lorsque les nouvelles technologies et les moyens de se les approprier sont disponibles, il naît une relation entre le système foncier et la productivité de l'exploitation.

L'objectif de cette étude est donc de mesurer l'efficacité relative des exploitations de la zone Ouest du Burkina Faso en fonction des modes de tenure des terres. Pour mesurer cette efficacité, nous allons utiliser la marge brute des exploitations en fonction des modes d'accès à la terre.

METHDOLOGIE DE L'ETUDE

1. Choix des villages

Cette étude a été réalisée dans les villages de Djigouéma et de Séguéré.Ces villages sont situés respectivement dans les zones d'encadrement agricole (ZEA) de Padéma et de Bama et sont des centres d'accueil de migrants venus du Nord. Jusqu'à une date récente le problème de l'accès à la terre ne se posait pas mais à présent le manque de terre est souvent une des causes des frictions entre autochtones et allochtones. L'accès à la terre est fonction des rapports inter-personnels qui s'établissent entre autochtones et migrants d'une part, et entre les migrants eux-mêmes d'autre part.

2. L'enquête et le traitement des données

L'enquête a débuté en Juillet 1989 avec le recensement de la population de chaque village. Celle-ci a ensuite été stratifiée en fonction des modes d'accès à la terre. Ainsi, on a pu distinguer quatre modes d'accès à la terre à Djigouéma et cinq à Séguéré.Il s'agit de l'accès à la terre par héritage (HER), par donation (DON), par prêt à long terme (PLT), par prêt à court terme (PCT) et par achat (AC) (uniquement à Séguéré). Ensuite 28 exploitations ont été choisies à Séguéré et 25 à Djigouéma en fonction des modes d'accès à la terre (Tableau 1). Ces exploitations ont été suivies régulièrement de Juillet 1989 à Avril 1990 afin de collecter des informations sur les superficies cultivées, l'équipment, la force de travail,l'utilisation et le coût des intrants,les productions agricoles,le cheptel et l'allocation des ressources.

Les questionnaires conçus pour la circonstance ont été administrés par deux enquêteurs. Les données collectées ont été d'abord traitées manuellement puis saisies avec le logiciel DBASE III. L'analyse a été effectuée à l'aide du logiciel CSTAT.

3. Principe de calcul des marges brutes et critères de comparaison

Dans la présente étude, le calcul des marges brutes a un but financier et non économique. Il vise simplement à connaître la rentabilité financière des exploitations en fonction des modes d'accès à la terre. La marge brute d'une production est la différence entre la valeur de la dite production et celle de tous les facteurs consommés ou utilisés dans le processus de production à l'exception de la main d'oeuvre familiale. En d'autres termes, c'est la valeur du produit diminuée des coûts de production. Afin de déterminer le mode de tenure le plus efficace, trois critères de comparaison ont été utilisés : la marge brute par exploitation afin de connaître les performances des exploitations, la marge brute par hectare et par journée de travail afin de connaître la rentabilité des productions par unité de surface et par homme-jour. Ces critères ont été utilisés selon trois points de vue. Le premier est celui des cultures vivrières et le deuxième, celui des cultures de rente. Il s'agit dans ces deux premiers cas, de déterminer si l'efficacité des exploitations varie suivant le type de culture. Le troisième point de vue est celui de la marge brute globale de l'exploitation. On cherche à déterminer si le mode d'accès à la terre influence le résultat global des exploitations. La marge brute des cultures vivrières est la somme des marges brutes du sorgho, du mil et du maïs. La valeur de la production vivrière sera la somme de la valeur de chacune de ces cultures. Les charges variables sont la somme des charges réelles de production des cultures vivrières, c'est à dire, le coût des engrais, des produits phytosanitaires et de la main d'oeuvre salariée. La marge brute du coton est la valeur de la production, diminuée des charges variables (coût des engrais, des semences, des produits phytosanitaires, du travail salarié). La marge brute de l'exploitation est la différence entre la valeur de la production totale et celle de tous les facteurs consommés ou utilisés dans le proces-sus de production, à l'exception de celle de la main

d'oeuvre familiale.
Les prix utilisés dans le calcul sont les prix officiels aux producteurs de la campagne agricole 1989-1990. Le coût de la main d'oeuvre salariée est celui recueilli lors de l'enquête. Il est de l'ordre de 700 F CFA/journée de travail (hj), 7500 F CFA pour un hectare (ha) labouré avec la traction animale et 15000 F CFA avec le tracteur.

RESULTATS et DISCUSSION

Les résultats seront examinés selon les rubriques suivantes:
- Marge brute des cultures vivrières
- Marge brute du coton
- Marge brute globale

Dans chaque rubrique,les moyennes et les écart-types des différentes marges brutes (marge brute par exploitation, marge brute/ hectare, marge brute/homme-jour) seront analysés. Cette analyse est chaque fois ventilée en fonction du mode d'accès à la terre qui introduit les différences induites par le statut du capital.

1. Les marges brutes des cultures vivrières

D'une manière générale, les marges brutes sont plus élevées à Séguéré qu'à Djigouéma. Les écarts-types observés sont assez importants et donnent une idée de ce que peut être la dispersion des revenus entre les exploitations (Tableau 2). Par ailleurs, le tableau 3 montre que les marges brutes (Cultures vivrières) par exploitaition sont beaucoup plus différenciées à Séguéré qu'à Djigouéma. C'est la tenure par héritage à Séguéré qui donne la plus forte marge brute et l'on constate aussi que les écarts-types sont très importants.

A Djigouéma, les marges brutes (cultures vivrières) par exploitation sont sensiblement identiques, que la terre provienne de l'héritage, du don ou du prêt à long terme. Le test de F montre qu'il n'existe pas de différence significative entre les moyennes observées. C'est dans la catégorie du mode d'accès par héritage que l'écart-type est le moins important, la dispersion par rapport à la moyenne étant la plus forte pour les terres prêtées à long terme. Le test de F appliqué aux écarts entre les marges brutes (cultures vivrières) est destiné à démontrer que ces écarts sont significativement différents entre eux. Ce test a permis de rejeter l'hypothèse nulle d'égalité des moyennes au seuil de 1% pour la marge brute par exploitation. Cette hypothèse est, par contre, acceptée lorsque l'on considère les marges brutes (cultures vivrières) par hectare et par homme-jour (tableaux 4 et 5). On en déduit que les différences constatées par exploitation découlent de la superficie cultivée et non d'une différence des marges brutes (cultures vivrières) par hectare ou par homme-jour. Il existe donc une relation positive entre marge brute (culture vivrières) et taille de l'exploitation. Les tableaux 4 et 5 montrent également que les marges brutes (cultures vivrières) par hectare et par homme-jour sont les plus élevées quand la terre est obtenue par donation.
Pour les marges brutes (cultures vivrières) par hectare et par homme-jour, les écarts observés sont significativement différents entre eux respectivement aux seuils de 1% et 5%. Les marges brutes (cultures vivrières) par hectare et par homme-jour sont les plus élevés avec le mode de tenure par héritage, les plus faibles en tenure par donation. Il semble que les bénéficiares de prêts et d'héritages aient adopté des systèmes d'assolement qui leur permettent d'avoir de meillleures marges brutes (cultures vivrières) par hectare et par homme-jour, ce qui compense l'écart de superficie qui les désavantage vis-à-vis des tenanciers par donation. Pour l'ensemble des cultures vivrières, les exploitaitons qui accèdent à la terre par héritage ou prêt à long terme se montreraient donc plus efficaces que celles qui y accèdent par donation. Les différences constatées entre Séguéré et Djigouéma proviennent de deux principaux facteurs :
- Une agriculture plus évoluée à Djigouéma
- Une moindre disponibilité en terres à Djigouéma qui impose une intensification de l'agriculture.

2. Les marges brutes du coton

Si la marge brute(coton) par exploitation est la plus grande à Djigouéma, c'est à Séguéré qu'on trouve les plus grandes marges brutes (coton) par hectare et par homme-jour (tableau 6). Le tableau 7 montre que les disparités entre des marges brutes(coton) par type d'exploitation sont souvent énormes. Toutefois, les moyennes observées ne sont significativement différentes entre elles au seuil de 5% qu'à Djigouéma.

L'application du test de F montre que les moyennes observées pour les marges brutes (coton) par hectare et par homme-jour ne sont pas statistiquement différentes entre elles dans les deux villages (tableaux 8 et 9). On en déduit qu'elles ne varient pas en fonction du mode d'accès à la terre. Ce résultat suggère que les coûts de

production sont proportionnels à la productivité physique. De ce fait, les variations qui existent dans la productivité physique disparaissent lorsqu'on monétarise la récolte et qu'on déduit les coûts de production. Le capital investi est donc très peu, voire pas rémunéré du tout. A Séguéré, le fait que les marges brutes (coton) par exploitation ne connaissent que peu d'écarts peut s'explique de deux façons:

- les superficies cultivées ne sont pas statistiquement différentes entre elles;

les marges brutes (coton) par hectare et par homme-jour sont sensiblement les mêmes.

A Djigouéma, la marge brute (coton) par exploitation est la plus élevée pour les exploitations qui détiennent la terre par héritage et la plus faible pour celles qui font des prêts à court terme. Les marges brutes (coton) par hectare et par homme-jour ne diffèrent pas sensiblement, les différences de marge brute par exploitation relèvent donc seulement des différences de superficies cultivées. Il existe une relation positive entre la superficie cultivée en coton et le niveau de marge brute (coton) de l'exploitation.

Dans les deux villages, l'analyse des ecart-types montre que la distribution des marges brutes (coton) est très hétérogène. Pour les marges brutes (coton) par hectare et par homme-jour, cette hétérogénéité serait due à la variation de la productivité par hectare et par homme-jour pour un même mode d'accès à la terre.

3. Les marges brutes globales

Le tableau 10 montre que les marges brutes (globales) sont pratiquement les mêmes pour les deux villages, que ce soit par exploitation ou par hectare. Par contre la marge brute par homme-jour est nettement plus élevée à Séguéré qu'à Djigouéma. On trouve une dispersion plus importante à Séguéré qu'à Djigouéma en ce qui concerne les marges brutes (globales) par exploitation et par homme-jour. En revanche, les marges brutes (globales) par hectare sont très voisines. La distribution des marges brutes (globales) entre les exploitations serait plus homogène à Djigouéma.

L'analyse de la structure des marges brutes globales montre que le vivrier en constitue la part la plus importante (70 à 100% à Séguéré et 79 à 92% à Djigouéma). Il n'y a qu'à Djigouéma et dans les exploitations qui accèdent à la terre par héritage que la culture du coton représente une part de la marge brute (globale) supérieure à celle du vivrier (59% contre 41%). Le revenu monétaire étant une priorité pour ces exploitations, elles pratiquent une agriculture plus attachée à la rationalité technique et économique. Pris par village (tableau 11), la tenure par héritage donne les plus fortes marges brutes (globales), les plus faibles revenant aux terres prêtées à court ou à long terme. Le test de F permet de rejeter l'hypothèse nulle d'égalité des moyennes au seuil de 5% à Séguéré et de 1% à Djigouéma. En considérant les marges brutes (globales) par ha et par hj (tableaux 12 et 13), le test de F permet d'accepter l'hypothèse nulle d'égalité des moyennes à Séguéré. Les marges brutes (globales) par hectare et par homme-jour ne varient pas en fonction du mode d'accès à la terre. Les variations constatées pour les marges brutes (globales) par exploitation dépendent donc du facteur taille. Il y a donc une relation positive entre la superficie cultivée et la marge brute (globale) de l'exploitation.

A Djigouéma, l'hypothèse nulle d'égalité des moyennes est rejetée au seuil de 1% pour la marge brute (globale) par hectare et au seuil de 10% pour la marge brute (globale) par homme-jour. Le niveau des marges brutes (globales) par exploitation dépend donc de l'effet combiné de la taille de l'exploitation et des marges brutes (globales) par hectare et par homme-jour. Les meilleures marges reviennent aux exploitations qui accèdent à la terre par héritage et les plus faibles revienent à celles qui l'obtiennnent par donation.

4. La rentabilité de la main d'oeuvre par journée de travail

La marge brute globale représente la rémunération implicite du travail familial, c'est son coût d'opportunité. Les exploitationsne devraient donc pas vendre le travail à un prix inférieur à la marge brute globale par homme-jour. Etant donné que le salaire moyen est de 700 CFA par homme-jour dans la région, nous avons procédé à un test de student afin de comparer la marge brute globale au salaire moyen. A cet effet nous avons formulé deux hypothèses:

$H_o : \mu = 700$ F

$H_1 : \mu \# 700$ F

où μ représente la marge brute globale par homme jour des différentes exploitations. Ce test a permis d'accepter l'hypothèse H_o

au seuil de 5% pour l'ensemble des modes de tenure des terres, à l'exception de la tenure par donation à Djigouéma. Dans cette dernière configuration, la marge brute globale par homme-jour est inférieur au salaire moyen d'une journée de travail, ce qui implique que les exploitants auraient intérêt à vendre leur force de travail plutôt que de chercher à produire eux-mêmes. Les autres exploitations peuvent indifféremment produire par elles-mêmes ou vendre leur force de travail, le résultat financier serait le même.

CONCLUSION

A Séguéré, seules la marge brute (cultures vivrières) par exploitation et la marge brute globale varient suivant le mode d'accès à la terre. A Djigouéma, les marges brutes par exploitation des cultures vivrières, du coton et la marge brute globale par exploitation varient suivant le mode d'accès à la terre. Il en est de même des marges brutes par hectare et par homme-jour des cultures vivrières.

Les marges brutes les plus élevées sont le fait des exploitation qui ont accédé à la terre par héritage. Viennent ensuite les exploitations qui ont profité de donations. Les exploitations fonctionnant sur prêt, pauvres en terres, ont les marges brutes les plus faibles.De ce qui précède, on peut conclure, toutes choses égales par ailleurs:

- En se basant sur les marges brutes globales, les exploitations qui reçoivent terre par héritage sont plus efficaces que celles qui bénéficient d'attributions coutumières ou d'achats.
- En se basant sur les marges brutes par hectare ou par journée de travail, la conclusion est moins nette: à Séguéré (pression foncière faible), on observe indépendance entre efficacité et mode d'accès à la terre; à Djigouéma (pression foncière forte), il existe une relation entre efficacité et mode d'accès à la terre.

En matière de politique fonçière, l'implication de ces résultats est la suivante: donner plus de terres aux exploitations qui accèdent à la terre par attribution coutumière entraînerait à Séguéré, l'augmentation des revenus et la réduction des écarts entre exploitations tandis qu'à Djigouéma, on observerait une augmentation des revenus, la réduction des écarts entre exploitations, comme à Séguéré, mais en plus il y aurait augmentation des marges brutes par hectare et par homme-jour.

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Tableau 1 Répartition des exploitations rentenues pour l'étude, suivant les modes d'accès à la terre

	SEGUERE		DJIGOUEMA		TOTAL VILLAGE	
	NBRE EA[1]	% ECH[2]	NBRE EA	% ECH	NBRE EA	% ECH
Héritage	5	17,8	5	20	10	18,9
Don	5	17,8	5	20	10	18,9
Prêt à long terme	8	28,6	10	40	18	34,0
Prêt à court terme	6	21,4	5	20	11	20,7
Achat	4	14,3	0	0	4	7,5
Total	28	100,0	25	100	53	100,0

Source: données de l'enquête
1 = nombre d'exploitations
2 = échantillon

Tableau 2 : Marges Brutes Moyennes des cultures vivrières (en F CFA)

	Par exploitation	Par hectare	Par homme-jour
Séguéré	248.090	42.890	765
Ecart-type	182.480	42.890	445
Djigouéma	223.720	36.700	685
Ecart-type	112.065	45.890	685

Source: Résultats d'enquête

Tableau 3: Marges Brutes (cultures vivrières) par exploitation agricole en fonction du mode d'accès à la terre (en F CFA)

	Herit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne	415726	336926	191596	110590	246745	3,16*
éc. type	317943	91081	109410	69250	107758	-
Djigouéma (moyenne)	235545	252212	251014	128564	-	1,65
éc. type	76637	102193	123773	106764	-	-

Hérit. = Héritage
Prêt LT = Prêt à long terme
Prêt CT = Prêt à court terme
F = résultat du test de F (*** = significantif au seuil de 1%)

Tableau 4: Marges Brutes (cultures vivrières) par hectare en fonction du mode d'accès à la terre (en F CFA)

	Herit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	45158	54873	44406	36157	32145	1,21
éc. type	19150	17285	21217	10621	15639	-
Djigouéma (moyenne)	46584	27396	39818	29365	-	3,79***
éc. type	10600	7151	14770	13124	-	-

Hérit. = Héritage
Prêt LT = Prêt à long terme
Prêt CT = Prê à court terme
F = résultat du test de F. (*** = significatif au seuil de 1%)

Source: Données de l'enquête

Tableau 5: Marges Brutes (cultures vivrières) par Homme-Jour en fonction du mode d'accès à la terre (en F CFA)

	Hérit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	820	880	849	585	655	0,44
éc. type	376	335	704	162	337	-
Djigouéma (moyenne)	977	506	702	567	-	4,13***
éc. type	223	155	273	251	-	-

Source: Données de l'enquête.

Tableau 6 Marges Brutes Moyennes (Coton)

	Par exploitation	Par hectare	Par homme jour
Séguéré	111.220 F CFA	78.400 F CFA	745 F CFA
Ecart-type	99.190 F CFA	36.200 F CFA	-
Djigouéma	162.085 F CFA	72.700 F CFA	570 F CFA
Ecart-type	174.450 F CFA	31.145 F CFA	570 F CFA

Source: Données de l'enquête.

Tableau 7: Marges Brutes (coton) par exploitation agricole en fonction du mode d'accès à la terre (en F CFA)

	Hérit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	177180	142241	82345	48581	-	1,48
éc. type	185138	76374	48917	41068	-	-
Djigouéma (moyenne)	341884	100301	45876	68560	-	5,13**
éc. type	195608	82375	16960	57962	-	-

Source: Données de l'enquête.

Tableau 8: Marges Brutes (coton) par hectare en fonction du mode d'accès à la terre (en F CFA)

	Hérit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	60950	72060	70868	109703	-	1,20
éc. type	36254	22631	39840	40090	-	-
Djigouéma (moyenne)	86738	79095	58245	66700	-	0,64
éc. type	22265	54633	10996	16332		

Hérit. = Héritage
Prêt LT = prête à long terme
Prêt CT = prêt à court terme
F = résultat du test de F.

Source: Données de l'enquête.

Tableau 9: Marges Brutes (coton) par Homme Jour en fonction du mode d'accès à la terre (en F CFA)

	Hérit	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	532	843	737	875	-	0,61
éc. type	236	424	423	386	-	-
Djigouéma (moyenne)	681	582	448	516	-	0,53
éc. type	243	412	170	225	-	-

Source: Données de l'enquête.

Tableau 10: Marges Brutes Moyennes (globales)

	Par exploitation	Par hectare	Par homme jour
Séguéré	322 620 F CFA	46 040 F CFA	825 F CFA
Ecart-type	235 845 F CFA	16 960 F CFA	495 F CFA
Djigouéma	320 970 F CFA	41 145 F CFA	630 F CFA
Ecart-type	212 540 F CFA	16 840 F CFA	260 F CFA

Source: Données d'enquête

Tableau 11: Marges Brutes (globales) par exploitation agricole en fonction du mode d'accès à la terre (en F CFA)

	Hérit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	557 470	449 727	273 940	134 880	249120	3,92**
éc. type	384 780	159 077	137 745	79 737	108265	
Djigouéma (moyenne)	577 430	319 080	271 403	155 985	-	5,71**
éc. type	229 740	160 426	143 360	152 335	-	-

Source: Données d'enquête

Tableau 12: Marges Brutes (globales) par hectare en fonction du mode d'accès à la terre (en F CFA)

	Hérit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré	50 755	55 960	48 040	40 860	31 500	1,54
éc. type	14 145	15 435	19 260	15 105	14 515	-
Djigouéma (moyenne)	64 150	31 018	40 630	31 220	-	8,63**
éc. type	14 460	8 190	11 190	14 785	-	-

Source: Données d'enquête

Tableau 13: Marges Brutes (globales) par homme jour en fonction du mode d'accès à la terre (en F CFA)

	Hérit.	Don	Prêt LT	Prêt CT	Achat	F
Séguéré (moyenne)	1050	940	780	620	800	0,69
éc. type	540	285	750	205	341	-
Djigouéma (moyenne)	880	490	625	530	-	2,86*
éc. type	285	155	240	215	-	-

Hérit. = Héritage
Prêt LT = Prêt à long terme
Prêt CT = Prêt à court terme
F = résultat du test de F:
* significatif à 10%
** significatif à 5%
*** significatif à 1%

Source: Données d'enquête

EVALUATION OF THE RESPONSE OF SOME YAM CULTIVARS (*DIOSCOREA* SPP.) AND PLANTING METHODS TO YAM MINISETT TECHNIQUE IN THE SUB-HUMID ZONE OF CROSS RIVER STATE OF NIGERIA

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SUMMARY

Five yam cultivars were evaluated for their response to the yam minisett technique using three planting methods in 1989 and 1990 in Ogoja Zone of Cross River State. Yield, profitability, benefit-cost ratio, return to capital and labour and acceptability of the minisett technique were assessed.

All the five yam cultivars responded to the minisett technique and planting method. *Dioscorea alata* (cv. *Ojujue), Oturogo, Ogboja, Ifala,* and *Ogakwu* gave the highest total seed yam yield in that order. *D. alata* spp. responded better to the minisett technique than *D. rotundata* spp. irrespective of the planting method. Direct sowing early and the pre-sprouting method of sowing yam minisetts were superior to direct sowing late except where *D. alata* (cv. *Ojujue*) was used.

The economic indices suggest that *D. alata (cv. Ojujue)* and *Oturogo* are viable cultivars for use in seed yam production by the minisett technique.

Keywords: Yam cultivars, responses, yam minisett technique.

RESUME

Cinq cultivars d'igname ont été examinés en vue de déterminer leur réaction à la technique de microbouturage en utilisant trois modes de semis au cours des années 1989 et 1990 à Ogoja dans l'Etat de Cross Rivers. Parmi les éléments évalués figurent le rendement, la rentabilité, le ratio coût/profit, le rendement du capital ainsi que la main d'oeuvre et l'acceptabilité de la technique de microbouture.

Tous les cinq cultivars ont répondu à la technique et au mode de semis des microboutures. *Dioscorea alata* (cv. *Ojujue) Oturogo, Ogboja, Ifala et Ogakwu* dans cet ordre ont donné les rendements en tubercules d'ignames les plus élevés. Les resultats ont montré que *D.alata* spp. répond mieux que *D. rotundata*, à la technique de microbouture quel que soit le mode de semis utilisé. Le semis précoce direct et la méthode de prégermination des microboutures donnent de meilleurs résultats que le semis tardif direct, sauf dans le cas de *D. alata.*

Les indices économiques indiquent que *D. alata (Ojujue) et Oturogo* sont des cultivars qui peuvent être utilisés dans la production de semences d'igname au moyen de la technique de microbouture.

Mots clés: Cultivars d'igname, réponse, technique de microbouture d'igname.

INTRODUCTION

Nigeria is the World's largest producer of yams, accounting for about 74.3% of the total world production (FAO, 1974, 1975). Yams are important for their high calories (5.7 million Kcal/ha) and protein (107 kg/ha), (Coursey and Booth, 1977). On dry matter content basis, the amount of protein in yams is about the same as that in some of the grains (Coursey and Haynes, 1970). Several *Dioscorea alata* spp. contain up to 12% protein while *Dioscorea rotundata* spp. contain up to 5% protein and have a fairly good amino-acid composition although sulphur-containing amino-acids seem to be limiting (Harvey, 1981). In spite of the importance of yams in calorific and protein intake of Nigerians, its production is dwindling mainly because it is an expensive enterprise when compared to other root and tuber crops such as cassava. Nweke (1980), Otoo and others (1988) and Ezeh (1988) identified seed yams as the major input among others accounting for the high cost of yam production. Yam is propagated vegetatively and whole tubers weighing between 100g and 1,500g or cut-pieces, referred to as setts, are usually sown. Thus, the quantity of yams required to crop up one hectare is about three tonnes even though the ex-

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pected yield is not more than four times the weight planted (Okoli, *et al*, 1982). It is this low multiplication ratio that is one of the major limiting factors in yam production. The development of the yam minisett technique for rapid seed yam production was a major attempt to solve this problem (Okoli, *et al*, 1982). Okoli and others (1982) defined minisett as a sett less than one quarter of the minimum, (100g) of yam usually sown. By this technique, the quantity of seed yams required for sowing one hectare could be produced from about one quarter of the total quantity usually required for sowing the same area. It is, however, recognised that different cultivars of yams respond differently to the technique (Okoli *et al*, 1982).

The objective of this trial was therefore to evaluate the common yam cultivars in Cross River State of Nigeria for their suitability in the minisett technique.

MATERIALS AND METHODS

A two-year (1989 and 1990) researcher-managed, farmer-executed on-farm trial was conducted in Ekumtak, Igoli, Ishibori, Idum and Odajie of Ogoja Agricultural Zone of Cross River State. The area is in the derived savannah belt and situated at latitude 6° 41'N and longitude 8° 48'E. The rainfall pattern is bimodal and totals between 1,600 mm and 1,844 mm, begining in March/April and peaking in July and September. The mean annual temperature is above 20°C but less than 29°C (Oko *et al*, 1987).

The cropping system is mainly Yam-Cassava based mixed-cropping on soil types ranging from sandy loam, clay loam to clay-sandy-loam. The trial was established in late May of each year on farm lands that had been under fallow for three years. The farmer's practice of slash-and-burn system of land clearing was used. Ridges, 100cm apart, were manually made each year. The trial was a 3 x 5 factorial laid out in a randomised complete block design. The treatments were five yam cultivars (*Dioscorea rotundata* cv. *Ogboja, Ogakwu, Ifala, Oturogo* and *Discorea alata* cv. *Ojujue*) and three planting methods, namely, direct sowing early, pre-sprouting and direct sowing late. Direct sowing early, are those minisetts sown into the field at the time those for pre-sprouting were being sown into the nursery. Pre-sprouting method are those minisetts that were pre-sprouted in the nursery before transplanting into the field. Direct sowing late are those minisetts that were directly sown into the field at the time the pre-sprouted ones were being transplanted into the field.

The plot size was 5m x 5m and replicated five times. The minisetts, each weighing 25g, were obtained from a fairly cylindrical seed yam (20 - 25cm long) after slashing off about 5cm of the proximal and distal ends. Two centimeter thick discs were cut from the seed yam. Four minisetts were obtained from each disc by cutting along two perpendicular diameters of the disc (Okoli *et al*, 1982). The minisetts were treated with minisett dust (a fungicide/insecticide) at the rate of a sachet (10g) per 200 yam minisetts. They were planted using three different planting methods described above. Equal numbers of minisetts from the head, middle and tail portions of the seed yams were used in each treatment. The minisetts were planted into the field at a spacing of 25cm along the crest of the ridge 5 - 7cm deep, giving a plant population of 40,000 plants per hectare. The plots were weeded, 3, 8 and 12 weeks after sowing and fertilizer, NPK 15:15:15, was applied at 400 kg/ha 8 weeks after by side banding. The yam vines were staked using the pyramid method. Five yam stands from two adjacent ridges were trained to a stake 1.5-2 meters high. Percentage germination was taken at 4,6,8,10 and 12 weeks after sowing. The seed yams were harvested at maturity (28 weeks after sowing). Analysis of variance was carried out and the means were compared by the Duncan Multiple range test. Net benefits, return on capital and benefit-cost ratio were used to measure profitability. A simple direct survey was used to determine the potential acceptability among farmers of the technique.

RESULTS AND DISCUSSION

The data on germination, yield and acceptability rating showed similar trend for the 1989 and 1990 cropping seasons. The data were therefore pooled and the analysis, results and discussions were based on the means in the two cropping seasons.

The mean percentage germination is shown in Table 1. Germination increased with time in all yam cultivars. *D. alata* (cv. Ojujue) followed by Oturogo were the earliest cultivars to germinate and get established in the minisett technique, irrespective of the

planting methods. These two cultivars attained over 50% germination in only 6 weeks. Generally *D. alata* (cv. *Ojujue*), *Oturogo* and *Ogboja* attained 80% germination at 12 weeks (Table 1). Yam minisetts will therefore germinate and establish 4-8 weeks after planting irrespective of the yam cultivar or the planting method. They will also attain maximum establishment between 10-12 week after sowing, whether directly sown in the field or pre-sprouted depending on the cultivar. Late direct sowing i.e., at the time the pre-sprouted seedlings are being sown into the field, is not recommended except for *D. alata* (cv. *Ojujue*). Directly sown yam minisetts when sown early or pre-sprouted, germinated faster than when directly sown late, regardless of the yam cultivar (Table 2).

Although the yam minisetts sprouted, this was not uniform in all the plots. This is attributed to the portion of the seed yam from where the minisetts were obtained. For normal setts, those from the tail and middle portions sprout later than those from the head (Coursey, 1967; Okoli *et al*, 1982). Similar studies found no difference betweeen the rate of sprouting of the tail and the middle portion (Onwueme, 1973). It is therefore important for commercial production to group the minisetts into heads, middle and tail portions and to plant them seperately, in order to facilitate staking, training of vines as well as harvesting.

Dioscorea alata (cv. *Ojujue*), *Oturogo, Ogboja, Ifala* and *Ogakwu* gave the highest total seed yam yield in that order (Table 3). *Dioscorea alata* and *Oturogo* were also superior to all other cultivars in the yield of seed yams weighing between 200g and 500g (Table 4). Direct seeding early and the pre-sprouting method of sowing yam minisett were superior to direct sowing late, i.e. at the time of sowing pre-sprouted setts, irrespective of the yam cultivar used (Table 5). The average number of seed yam yield from minisett direct seeding and pre-sprouted method amounted to 97 and 88 percent of the total plant population per hectare respectively compared to 59 percent for direct sowing late. However, *Dioscorea alata* (cv. *Ojujue*) and *D. rotundata* (*Oturogo*) gave the highest seed yam yield irrespective of planting method (Table 5). The other yam cultivars did not give acceptable seed yam yields using the direct late seeding method. The very high response of *D. alata* spp. over *D. rotundata* spp to the minisett technique had been reported by Okoli and others (1982).

Labour accounts for 33 to 36 percent of the total variable costs in seed-yam production by the minisett technique (Table 6). Seed yams, stakes and interest on capital account for about 22%, 17% and 19% of the total variable costs, respectively. *D. alata* (cv. *Ojujue*) was the most profitable cultivar in the minisett technique irrespective of the planting method, while *Oturogo* and *Ogboja* were only profitable when directly sown early or pre-sprouted (Table 7). The labour productivity were also positive only for these cultivars. The benefit-cost ratio suggests that *D. alata* (cv. *Ojujue*) either directly sown early or pre-sprouted and *Oturogo* when directly sown early are economically viable methods of seed yam production by the minisett technique.

Direct sowing early and pre-sprouting methods can therefore be recommended for seed yam production by the minisett technique irrespective of the yam cultivar in the Cross River State. If direct sowing late cannot be avoided, only *D. alata* (cv. *Ojujue*) and *Oturogo* are likely to give good results. However, direct sowing early by this study is preferred to the pre-sprouting method because of the savings in labour and materials required in pre-sprouting. The lower man-days in the direct sowing late method were as a result of the poor sprouting and yield which resulted in the low man-day requirements for harvesting. The non-significant difference in the number of seed yam yield between yam minisetts directly sown early and those pre-sprouted, irrespective of the yam cultivar, suggests that the extra labour of 40.7 man-days, equivalent to 407.00 naira, could be saved by adopting the direct sowing early method without any loss in yield.

The economic efficiency indices suggest that *D. atala* (cv. Ojujue) and Oturogo were viable cultivars for use in the yam minisett technique for seed yam production by the direct sowing early method. Their benefit-cost ratio were greater than one, suggesting that for every N1.00 invested by the farmer, 1.66 naira and 1.10 naira will be realised for *D. alata* (cv. Ojujue) and Oturogo, respectively (Table 7).

Ninety percent of the farmers are willing to adopt the yam minisett technique for seed yam production on account of the fourfold increase in seed yam yield.

The acceptability rating with respect to planting method is shown in Table 8. The direct sowing early method was most preferred. The other 10% of farmers while agreeing that the technique was good, indicated that most of the seed yams produced by this technique did not meet the 1.5-2.5 kg size of seed yams usually planted by them. The direct sowing early method of seed yam production by the minisett technique coincides with the period when farmers have finished sowing their seed yams for ware yam production. They consequently would have adequate time to establish the yam minisett plot. This also probably accounted for the very high acceptability rating of this method.

CONCLUSION

Yam minisett from *Dioscorea* spp. will establish at 4 - 8 weeks and attain maximum establishment at 10 -12 weeks after planting. The non-uniformity of sprouting is attributed to the portion of the seed yam from where the minisetts were obtained. For commercial production of seed yams by this technique it is advisable to plant seperately the head, middle and tail portions of the minisetts so as to facilitate staking and training of yam vines. *Dioscorea alata* spp. responded better to the yam minisett technique than *Dioscorea rotundata* spp. irrespective of the planting method. The number of seed yam yield from the direct sowing early and pre-sprouting methods were statistically similar irrespective of cultivars, hence the extra labour of 40.7 man-days (or 407.00 naira) could be saved by adopting the former method.

The economic indices used suggest that *Dioscorea alata* (cv. *Ojujue*) and *Dioscorea rotundata* (cv. *Oturogo*) are viable cultivars for use in seed yam production by the yam minisett technique. The biological yield, return to labour and capital, and the high farmer acceptability potential of this technique offer a great opportunity for increasing seed yam production, which is the major limiting factor in yam production.

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Table 1: Mean percentage germination of yam cultivars in relation to time of sowing

Yam Cultivar	Percentage germination Weeks after sowing (WAS)				
	4	6	8	10	12
Ogboja	31.67	48.33	65.00	76.67	83.33
Ogakwu	26.67	48.33	68.33	71.67	73.33
Ifala	23.33	48.33	58.33	63.33	68.33
Oturogo	40.00	61.67	76.67	80.00	83.33
Water Yam (Ojujue)	63.33	75.00	83.00	86.67	88.33

Table 2: Mean percentage germination of minisett cultivars in relation to planting method and time

Yam cultivar	planting method	Percentage Germination Weeks after sowing 4	6	8	10	12
Ogboja	DE	30	50	70	80	85
	PS	40	60	75	85	90
	DL	25	35	50	65	75
Ogakwu	DE	20	50	70	75	80
	PS	40	55	75	75	85
	DL	20	40	65	69	70
Ifala	DE	20	50	69	75	80
	PS	30	60	70	70	75
	DL	20	35	50	60	50
Oturogo	DE	40	65	80	85	90
	PS	50	75	90	90	90
	DL	30	50	70	80	85
Water Yam	DE	60	80	90	95	95
	PS	80	85	95	95	95
	DL	50	60	65	70	75

DE = Direct Early, PS = Pre-Sprouting, DE = Direct Late

Table 3: Seed yam yield of the different yam cultivars and percentage of the population per hectare.

Cultivar	Mean seed yam yield (No/ha)	Percentage of the population
Ogboja	30,155.00	79.39
Ogakwu	27,928.67	69.82
Ifala	28,109.67	70.27
Oturogo	33,808.00	84.52
Water Yam (cv. Ojujue)	36,400.00	91.00

Table 4: Mean seed yam yield of the different cultivars in two weight categories

yam cultivar	Mean Seed yam yield (No/ha) 200 - 500g	Mean seed yam yield (No/ha) < 200g
Ogboja	19,094.67c	11,060.23a
Ogakwu	19,109.33c	8,819.33b
Ifala	16,682.67 cd	11,427.00a
Oturogo	25,462.00b	8,346.00b
Water Yam (Var.Ojujue)	29,345.67a	7,053.33b

Means in the same column followed by the same alphabet are not significantly different at 5% level (Duncan's New Multiple Range Test).

Table 5: Mean seed yam yield (No./ha) of the different cultivars in relation to planting method

Yam cultivar	Planting method		
	Direct Early (DE)	Pre-sprouting (PS)	Direct Late (DL)
Ogboja	33,643 84.11%	36,946 92.37%	19,876 49.69%
Ogakwu	32,949 82.37%	33,841 84.60%	16,996 42.49%
Ifala	32,744 81.75%	30,143 75.36	21,442 53.61%
Oturogo	36,132 90.33%	36,289 90.72%	29,003 72.51%
Water Yam (cv. Ojujue)	38,984 97.46%	39,102 97.76%	31,114 77.79%
TOTAL	174,452	176,321	118,431
MEAN	34,890.40	35,264.20	23,686.20
% of Total Population/ha	97.23	88.16	59.22

Table 6: Input-output in seed yam production by minisett technique in relation to cultivar and planting method

Item	Planting Method		
	Direct Early	Pre-Sprouting	Direct Late
Variable Costs[+]:			
Labour (man-day)	391.7	432.4	369.8
Labour at ₦10/man-day (₦)	3917.00	4324.00	3698.00
Physical Inputs (₦):			
Seedyams (1 tonne) or 5000 tubers at ₦0.50	2500.00	2500.00	2500.00
Stakes, 4000 at ₦0.50	2000.00	2000.00	2000.00
Fertilizer NPK 15-15-15:			
400 kg at ₦20/50kg	160.00	160.00	160.00
Piassava 200 bundles at ₦1.50	300.00	300.00	300.00
Minisett dust, 200 sachets at ₦1.50	300.00	300.00	300.00
Interest on Capital (25%)	2294.25	2396.00	2239.50
Total Variable Costs	11,471.25	11,980.00	11,197.50
Gross Output at ₦2,500/t[+] :			
Ogboja	14,125.00	19,950.00	3,050.00
Ogakwu	10,000.00	8,675.00	2,025.00
Ifala	9,875.00	5,450.00	2,725.00
Oturogo	24,100.00	18,650.00	8,625.00
Water yam (cv.Ojujue)	30,550.00	34,375.00	11,775.00

+ At 1989/90 prices.

Table 7: Profitability of seedyam production by the minisett technique in relation to cultivar and-planting method

Variety	Planting Method	Economic Indicators: Net Benefit (₦)	Return on Capital(%)	Return on Labour (₦)	Benefit-Cost Ratio
Ogboja	DE	2,653.75	23.13	6.77	0.23
	PS	7,970.00	66.53	18.43	0.67
	DL	-8,147.50	-72.76	-22.03	-0.73
Ogakwu	DE	-1,471.25	-12.83	- 3.76	-0.13
	PS	-3,305.00	-27.59	- 7.64	-0.28
	DL	-9,172.50	-76.57	-24.80	-0.77
Ifala	DE	-1,596.25	-13.92	- 4.08	-0.14
	PS	-6,530.00	-54.51	-15.10	-0.55
	DL	-8,472.50	-75.66	-22.91	-0.76
Oturogo	DE	12,628.75	110.09	32.24	1.10
	PS	6,670.00	55.68	15.43	0.56
	DL	-2,572.50	-22.97	-6.96	-0.23
Water Yam	DE	19,078.75	166.32	48.71	1.66
	PS	22,395.00	186.94	51.79	1.87
	DL	577.50	5.16	1.56	0.05

DE= Direct Early Planting; PS = Pre-Sprouting; DL Direct Late Planting.

Table 8: Farmers'acceptability rating of seed yam production by the minisett technique in relation to planting method

Planting Method	Acceptability Rating+
Direct Early	80
Pre-Sprouting	20
Direct Late	0

+ Where 0 = Not acceptable; 100 = Most acceptable
N= Total number of participating farmers responding(N = 10).

STUDIES ON COTTON FARMING PRACTICES IN ZAMBIA WITH EMPHASIS ON IDENTIFICATION OF PRODUCTION PROBLEMS AND RESEARCH NEEDS

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SUMMARY

A survey of farmers was carried out in three cotton growing areas of Zambia using a questionnaire approach. One of the objectives of the survey was to have an insight into cotton farming practices of smallholder farms and to detect the production problems faced by farmers. The survey showed that average cultivated area at selected farms was 15 hectares and the area under cotton was 3.7 hectares per farm. Apart from cotton, other crops grown by farmers were maize, sunflower, groundnut and soyabean. Cattle were also kept by 96% of the farmers, with an average of 33 heads of cattle per farm. Cotton was reported to be grown as a major cash crop in rotation with maize with an average yield of 735 / ha. Weeds and insects were reported to pose the major production problems as reported by 74% and 27% of the farmers respectively. Therefore, in order to encourage and sustain cotton production in smallholder farms more research is desperately needed to develop pest control strategies with emphasis on the use of herbicides and to integrate them with currently practiced cultural methods of control. In addition, more advice on the application of insecticides is essential.

Keywords: Cotton, Zambia, Farming Systems, Smallholder farmers, Production problems, Research needs.

RESUME

Une enquête a été menée auprès de certains paysans de trois zones de production cotonnière en Zambie. L'un des objectifs de l'enquête était de mieux comprendre comment se cultivait le coton, afin d'identifier les problèmes de production que rencontrent les paysans. Les résultats de l'enquête ont montré la superficie moyenne cultivée par les paysans sélectionnés était de 15 hectares avec une superficie cotonnière de 3,7 hectares par exploitation. En dehors du coton, les paysans cultivent également le maïs, le tournesol, l'arachide et le soja. Par ailleurs près de 96% des paysans élèvent du bétail avec une moyenne de 33 têtes par exploitation. Le coton représente la principale culture de rente et est cultivé en rotation avec le maïs avec un rendement moyen de 735 kg/ha. Pour la plupart des paysans interviewés, les mauvaises herbes et les insectes constituent les problèmes de production les plus importants. Par conséquent pour encourager et soutenir la production cotonnière au sein des exploitations agricoles, une recherche supplémentaire est absolument nécessaire en vue de mettre au point des stratégies de lutte contre les insectes et les mauvaises herbes en mettant un accent particulier sur l'utilisation des herbicides de manière à les intégrer aux méthodes de lutte couramment pratiquées. De plus, des conseils supplémentaires concernant l'utilisation des insecticides s'avère indispensables.

Mots clés: Coton, Zambie, systèmes de production, petits paysans, problèmes de production, besoins de recherche.

INTRODUCTION

Cotton is an important cash crop in many African countries, particularly of smallholder farms. In most of such countries it provides the basis for nationally important textile industries in the region and is a potential source of foreign exchange. However, the recommendations for cotton production on smallholder farms in many African countries have generally been based upon results from research stations and in some cases they have failed to put into consideration many basic problems of farmers. Such recommendations could be agronomically, socio-economically and ecologically unacceptable to the target farmers (Matteson et al., 1984). It is now commonly accepted that the development of the small sector in developing countries requires an agricultural technology that is specifically adopted to local agro-ecological and socio-economic conditions (Doorman, 1991). In order to understand the recommendations that farmers will use, one has to think in terms of farmers' constraints and problems (Perrin, *et al.*, 1979). The present study was therefore undertaken to gain an insight into current farming practices so as to understand the problems faced by farmers in cotton production and to facilitate the development of appropriate technologies that might be feasible and relevant to the farmer's situations. The information on description of farms, cotton farming practices, reasons for cotton production, major production problems

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and farmers' suggestions to solve various problems are reported in this study.

METHODOLOGY

Ninety smallholder cotton growers were randomly selected and interviewed in three cotton growing areas of Zambia. The selected areas were Magoye, Mukalaikwa and Keembe in Mazabuka, Mumbwa and Kabwe districts respectively. These areas have the highest number of cotton growers. The farmers were selected randomly from the lists available from extension officers in each area. A preliminary survey of eight farmers was also initially carried out to pre-test and improve upon the questionnaire.

RESULTS

The sample of farms included a wide range of different sizes. The smallest farm had an area of 1.6 hectares and the largest one had about 80 hectares. The distribution of farms according to three classes namely, small, medium and large is shown in Figure 1. The small farms had 11 to 20 hectares. The average cultivated land of the selected farms was about 15 hectares. The actual area under cotton crop reported by the farmers during the survey ranged from 0.8 to 8.8 hectares (Figure 2). But the average area under cotton of selected farms was 3.7 hectares. In addition to cotton, other crops grown by farmers include maize, sunflower, groundnut and soyabean. Table 1 shows the crops grown by different farmers and the hectarage under the various crops on an average farm. The range of areas (in percentages) under various crops such as maize, sunflower, groundnut and soya-bean of the selected farms is shown in Figures 3, 4, 5 and 6. The mean percentage area under maize, sunflower, groundnut and soyabeans of cotton farms was 43.2, 26.6, 10.4 and 6.6 percent respectively. Many farmers also grow several fruit trees such as mango, oranges, banana and guava. The types of fruits grown and the average number of fruit trees per farm are shown in Table 2 and Figure 7. Vegetables were grown by 24% of the farmers with an average area of 0.51 hectares per farm. The most common ones were cabbage and beans.

Cattle were kept by 96% of the farmers with an average number of 33.6 cattle heads per farm. The range of the number of cattle heads of different farms is shown in Figure 8. In addition to cattle, about 23% of the farmers also kept goats with as many as 12 goats per farm. The distribution of the yield of seed cotton reported by farmers is shown in Figure 9. The mean yield reported by farmers was 735 kg / ha. All farmers reported that the quality of cotton produced by them was of grade A.

The length of experience with cotton growing reported by the farmers ranged from 1 to 35 years with an average of 12 years (Figure 10). The farmers reported various reasons for growing cotton. Fifty-two farmers grow cotton because it is a cash crop; 24 said there was no fertilizer requirement; 19 said cotton is drought resistant; 12 do it because of the credit facility available to buy input while 10 reported that it was due to the advice from extension officers (Figure 11).

The farmers were asked whether they would like to increase or decrease the area under cotton on their farms during the next season. Seventy-four farmers (out of 90) said they would increase, 8 would decrease and another 8 would like to keep the same area under cotton during the next season (Figure 12). Out of those farmers who would like to increase the area under cotton 14 metioned that the no-fertilizer requirement was an incentive while six said that family labour availability was responsible. Three of the farmers mentioned better prices and three mentioned credit facilities as the contributing factors for willingness to increase production. Drought resistance and experience in growing cotton were other reasons given (Figure 13).

Pests were reported to pose the major production problems. Sixty-seven farmers reported weeds, 24 insect pests, 6 lack of training and 4 mentioned the harvesting of cotton as the major production problems of cotton (Figure 14). The farmers also suggested various solutions for the cotton production problems on their farms. Thirty-six farmers suggested the supply of herbicides for better weed control in cotton. Other solutions suggested included better advice, better weeding, more labour hiring and loan facilities (Figure 15).

DISCUSSION

In Zambia, over 90% of the cotton is produced by smallholder farmers, but the average area devoted to cotton was 37% of the total cultivated area on the selected farms. Cotton is a highly labour intensive crop and some production practices such as weeding, harvesting and pest control operations are

technically more demanding as compared to other crops. The farmers also make some allowances for maize, sunflower and groundnut (Mweetwa, *et al*, 1983). Maize occupied the maximum area (43%) of the selected farms probably due to low labour requirements as compared to cotton and it is also the staple food crop in Zambia. The farmers tend to specialize in three or four types of crops. Maize and other crops are mostly grown to meet household needs while the excess is sold. Cattle were the most important component of farming system and oxen are used in many farming operations. In addition to land preparation, seventy percent of the farmers used oxen for weeding their crops. Cattle are aslo used for transporting seed cotton from small villages to LINTCO (Lint Company of Zambia Ltd) depots. They could be seen grazing on cotton fields after cotton had been harvested. Cattle are also attacked by various pests such as ticks and therefore require pest control. About one third of the farmers reported that they used knapsack sprayers to apply pesticides on cotton (Javaid, 1989). Therefore, it was one of the main reasons reported by farmers for prefering knapsack sprayers to newly introduced Electrodyn sprayers in the selected areas. The development and introduction of new technologies should therefore be based upon the particular needs of the target group of farmers. The yield of seed cotton with an average of 735 kg/ ha is comparatively low. However, the yield potential of cotton in Zambia is high. Some smallholder farmers regularly obtain yields of 2000 to 2500 kg / ha as a result of good pest management practices (Lyon, 1975). The lower yields reported by farmers during the survey could be attributed to many factors, prominent among these could be high biotic pressure, particularly insect pests and weeds. Cotton provides the most important source of cash which was reported by 58% of the farmers. Indeed, farmers need cash to buy clothes and other basic commodities in addition to food crops. Cotton, because of its deep-rooting nature, is very useful in rotation with shallow-rooted crops such as maize. Traditionally, cotton grown after a well fertilized maize gives reasonable yields without the application of additional fertilizers and this was considered as an important factor by many farmers.

Cotton is an important crop in the farming systems of Zambia. The survey clearly shows that majority of the farmers tend to increase cotton production on their farms. Weeds and insect pests were identified as the major production problems in all the three localities. Hand - weeding (using hand - hoes) and ox - weeding were the methods of weed control reported by almost all the farmers. In order to control weeds, use of herbicides, as suggested by farmers, needs to investigated. Many farmers are willing to use herbicides in order to reduce the labour constraints. They were less concerned about the cost of herbicides and their effects on the environment. The decision makers should keep in view the constraints faced by farmers in order to increase and sustain cotton production on smallholder farms. Farmers also need more advice on the timing and the application of insecticides as well as technical knowledge which could be adapted to their circumstances (Morton, 1979).

Research efforts in Zambia should address the key problems in cotton farming systems. There is a desperate need to maximize research and extension collaboration. Cotton as an important crop in the economy of Zambia can improve the general living standards of farmers, and serve as an important source of employment. Therefore, cotton production needs to be encouraged on smallholder farms. More research effort and extension services are urgently needed on integrated pest management (IPM).

CONCLUSION

There is a great potential for expanding cotton cultivation in Zambia. Major production problems of the crop detected through the survey include weed competition, lack of labor for weeding and lack of training in the management of insect pests, particularly in scouting based sprays. The identification of these constraints is a valuable information which can stimulate future studies. A look at the feasibility, development and implementation of IPM technologies is highly desirable.

ACKNOWLEDGEMENT

Sincere thanks are due to farmers who participate in the survey.

Thanks are also due to Dr J.N. Zulu, Dr G.A. Mathews and Dr G.A. Norton for their help in the preparation of the questionnaires and for their valuable suggestions.

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Table 1: Types of crops grown by farmers in addition to cotton.

Crops	No. of farmers (out of 90)	Average hectarage per farm
Maize	89	6.51
Sunflower	68	3.30
Soybean	17	1.08
Sorghum	6	0.73
Groundnuts	71	1.31
Vegetables	22	0.51

Table 2: Types of fruits grown at farms

Crop	No. of farmers (out of 90)	Average number of trees per farm
Mango	56	10.89
Orange	21	7.33
Banana	35	9.85
Guava	17	5.76

Figure 1: Farm size.

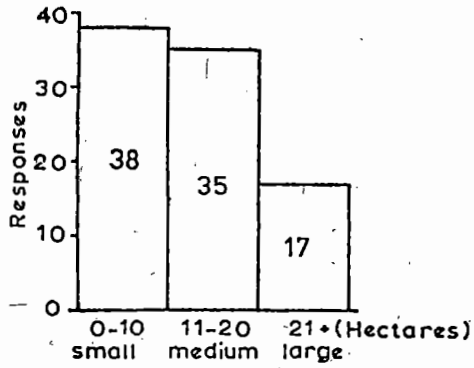


Figure 2: Area under cotton cultivation.

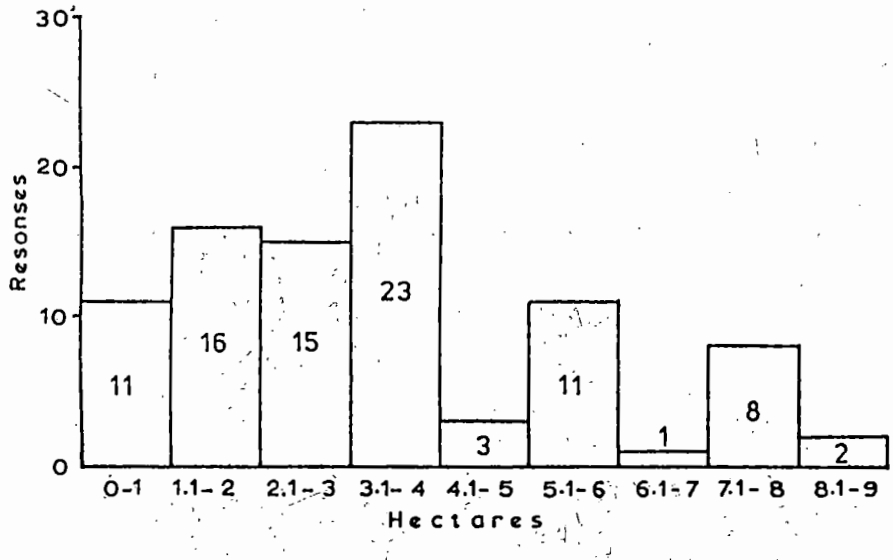


Figure 3: Maize, as percentage of total area of farms.

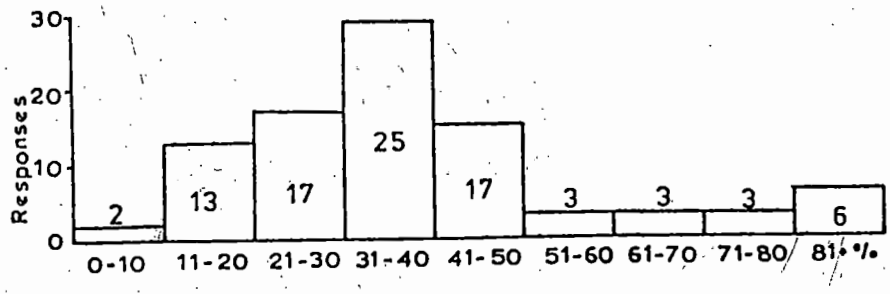


Figure 4: Sunflower, as percentage of total area of farms.

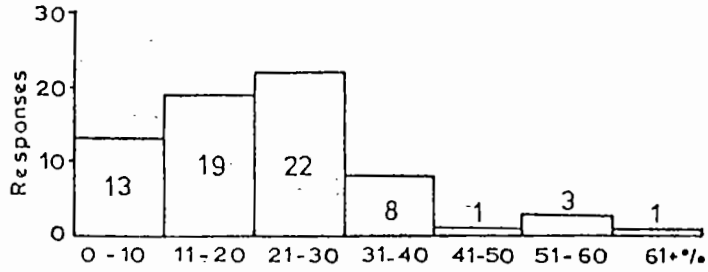


Figure 5: Groundnuts, as percentage of total area of farms.

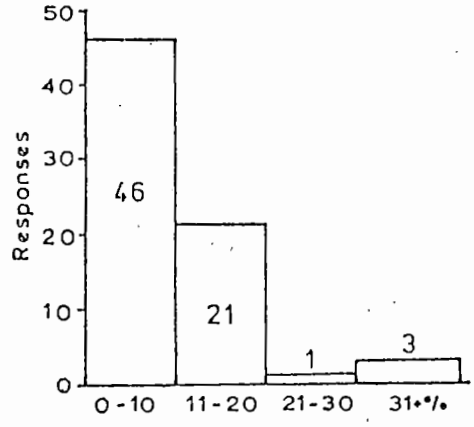


Figure 6: Soybeans as percentage of total area of farms.

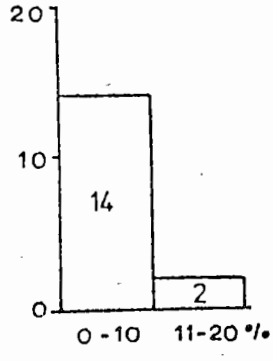


Figure 7; Range of trees at the farms.

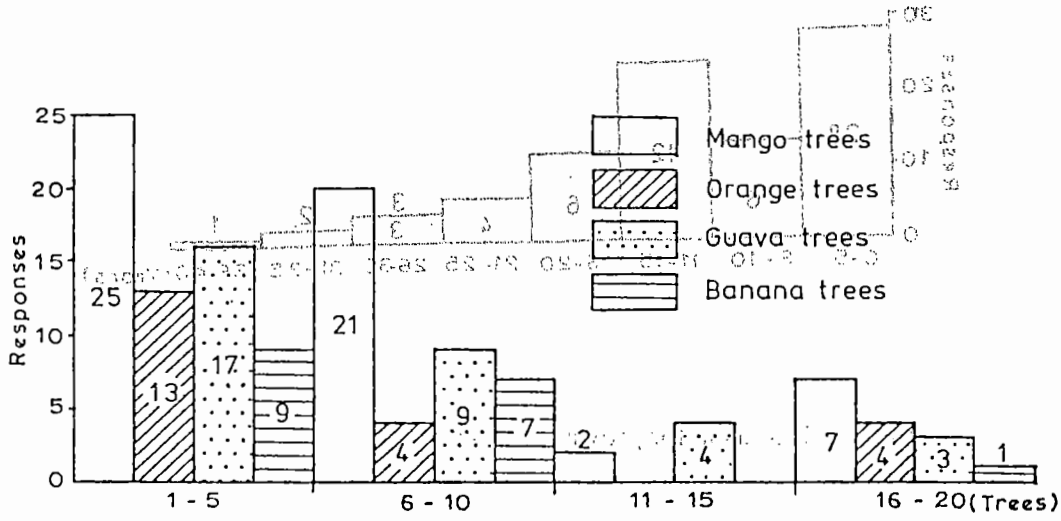


Figure 8: Numbers of cattle heads at the farms.

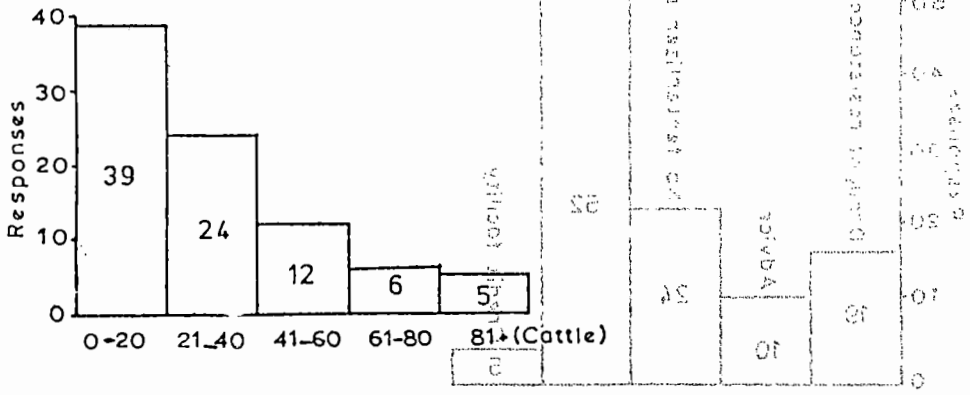


Figure 9: Yield of seed cotton in Kg/ha.

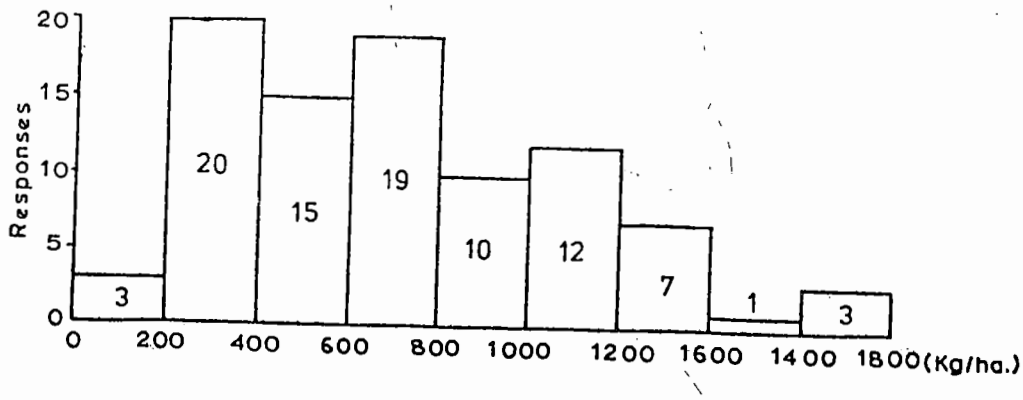


Figure 10: Experience of cotton growing in years.

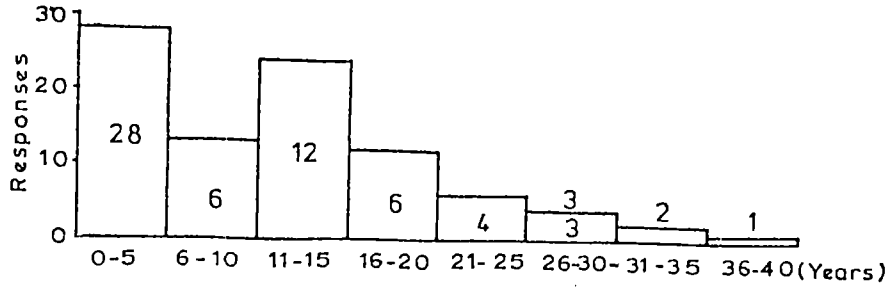


Figure 11: Reason for growing cotton.

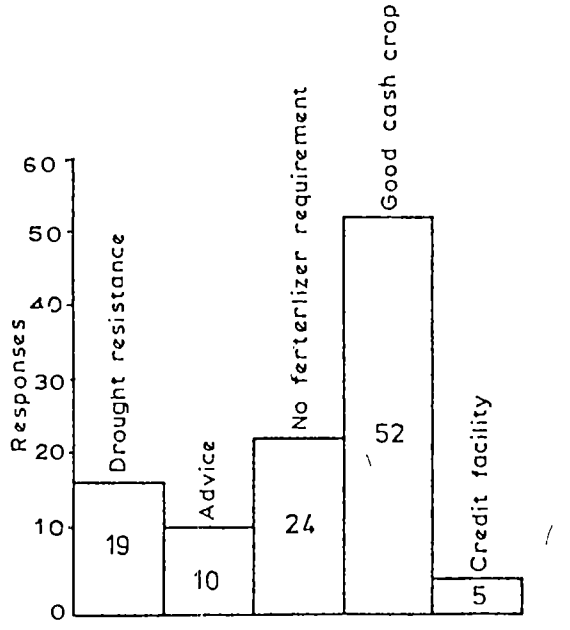


Figure 12: Increase in cotton production

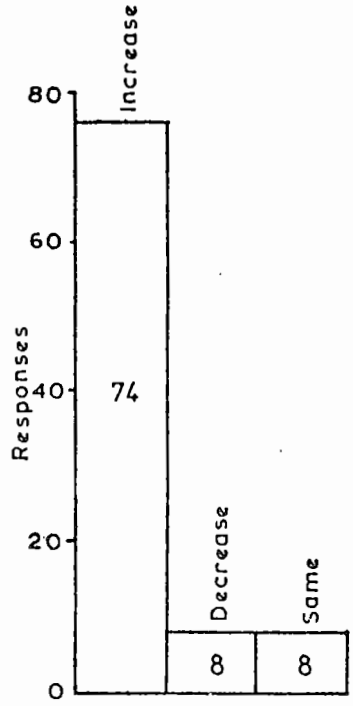


Figure 13: Reasons for increasing cotton production.

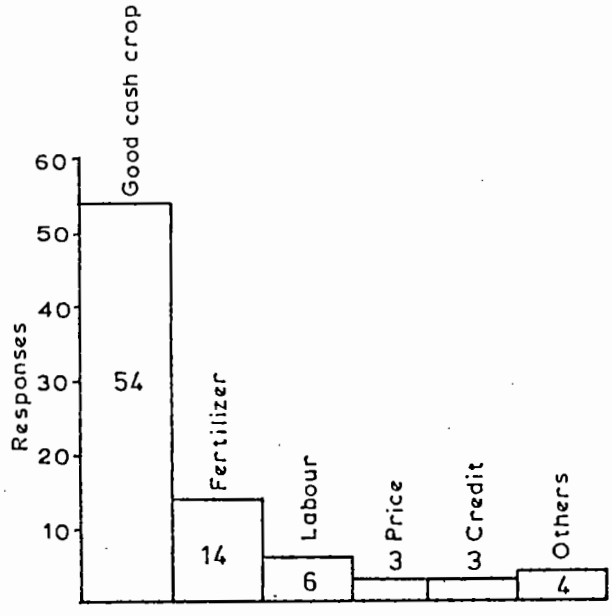


Figure 14: Cotton production problems.

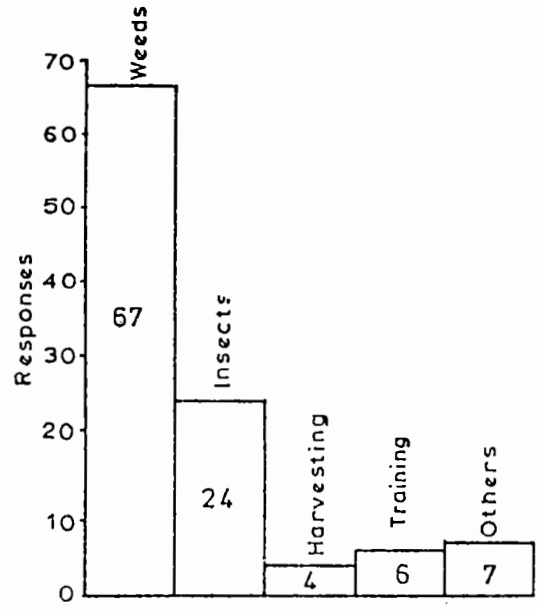
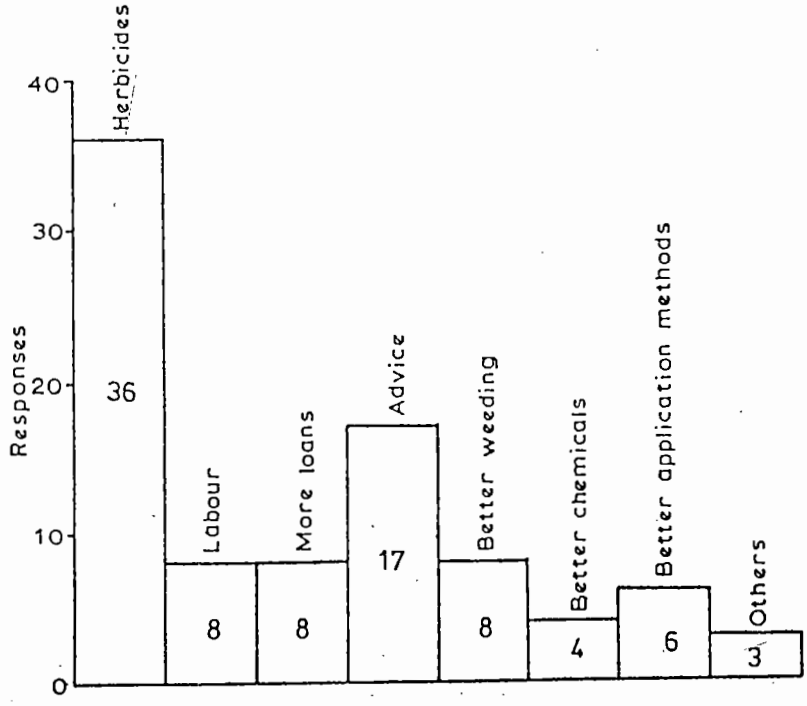


Figure 15: Suggested solutions of production problems.



AGRICULTURAL SYSTEMS IN AFRICA

INSTRUCTIONS FOR AUTHORS

GENERALITIES

A - General Policy

1 - The Journal

- *Agricultural Systems in Africa* is a bi-annual, multidisciplinary journal publishing original works in all fields of research in agricultural systems (farming systems, agrarian systems), including the problems of agricultural economics both at the local and regional levels. More specially, it publishes:

- basic research articles which should be original accounts of scientific research.

- articles on the state-of-the art or present scientific knowledge on selected topics.

- proceedings of scientific conferences on agricultural systems.

2 - Target audience

In order to be accepted, articles should address researchers, professionals of agricultural extension as well as agricultural policy-makers in the countries of sub-saharan Africa, West Africa or other regions of Africa.

3 - Submission of articles:

Manuscripts should be submitted to the editor in 3 copies (the original and two copies) or even better on disket and an original print out. In the last case, the names of the software used, of the file and of the author should be indicated. Either 5 1/2 or 3 1/2 high double density diskets can be used.

4 - Language of Publication:

Agricultural Systems in Africa publishes articles written in English or French. The titles of the articles, the summaries and the keywords are translated in the other language.

B - Specific Condition

- There should be no more than 4 authors to an article. However, it is possible to use a collective title (for example Collective Study on ...). In this case,the names of the authors should also be provided.

- Agricultural Systems in Africa publishes only works not yet published elsewhere. Once accepted, the articles can only be submitted to another journal with the consent of the editor of Agricultural Systems in Africa.

- Copyright of an article published in Agricultural Systems in Africa belongs to WAFSRN which reserves the right to publish or republish it in a form and language of its choice.

- Articles accepted for publication are thoroughly edited. The editing goes as far as compressing the text and/or suppressing tables and illustrations.

- Authors should provide the necessary permission for the publication of any copyright material they wish to include in their articles.

II-MANUSCRIPT

II- 1 Generalities: The original and two copies of the final manuscript must be sent to the editor. The manuscript must be typed or printed on clean white paper, preferably format 21 cm x 27,7 with a margin of at least 4 cm for corrections. Typing should be done only on one side of the sheet. All parts of the manuscript must be typed in double spacing. Only the words to be printed in italics need to be underlined.

The front page should include only the title, the name(s) of authors (s), their full office addresses and any required footnote. All the pages should be numbered consecutively. The first line of each paragraph in the text and of all captions and footnotes must be indented. The author should proof-read the manuscript before the final typing.

II-2. **The title** of the paper must be concise while reflecting clearly the content. It should be followed by the full names and addresses of the authors.

II-3. **The abstract**: Papers should be accompained by an abstract of 200 words at most, written in a concise and clear style and indicating the major objective, results and conclusions. If possible, authors are encouraged to provide an abstract and keywords in both French and English References are not to be mentioned in the abstract

II-4. **The text**: Papers should be written in a clear and concise way and should contain only essential information. The text content should be understan-dable without the help of the tables and figures.

II-5. **Figures and Tables:** Each table must have its title and each figure its caption. These will enable the reader to understand the content of the figures and tables without having to refer to the paper text. Figures and Tables must have a serial number (Fig 1, Fig 2; Table 1, Table 2, etc). Tables (with titles) and Figures (with captions) must be separated from the text and put at the end of the manuscript. Their location in the text shall however be indicated in the margin of the text with a pencil. Tables must be typed in double spacing.

Figures shall be drawn with black ink on white or transparent paper. Their sizes shall be about the double of the space in the ultimate article. Letters in the figures must be quite readable after reduction. Original line drawing and two series of clear copies should be submitted (for simple drawing, three sets of glossy photocopies may be accepted). For identification purposes, the name(s) of author(s), the title of the paper and the number of table or figure must be indicated on the back of each figure or table.

II-6. Bibliographic references: They should be typed in double spacing and in alphabetical order at the end of the paper as follows: name and initials of authors; year of publication (successively distinguished by letters a, b etc. added to the date if several publications by the same author are quoted for the same year); exact title of article; full name of journal, number of volume in arabic numeral, first and last page of article. In the text, publications must be quoted with the name(s) of author(s) and year of publication in brackets: e.g (Koffi, 1986) or Koffi (1986); Faye and Dubré (1988 a, b). For references with more than two authors only the first one is quoted in the text, followed by "et al" while in the bibliography all authors should be mentioned. References to sources other than journals, (e.g. books) should include the name of the editor and the place of publication. Each reference quoted in the text must appear in the bibliography and vice-versa. Generaly more than 15 references should not be quoted.

III-GUIDELINES ON THE STRUCTURE OF A PAPER

A paper on research work is generally stuctured as follows:

III-1. **The abstract** before the presentation of the reports is mainly designed to help the reader who has gone through it to decide whether he should continue to read the paper or proceed to another activity. As previously indicated, the abstract should inlcude only the essential, that is the main results and conclusions and sometimes also the major objective (this is not often indispensable).

III-2. **The text** itself is subdivided into sections:

III-2-1. **The introduction** in which the author explains to readers (i) why he has initiated the work and (ii) what were his objectives.

III-2.2 **"Materials and methods or "methodology"**: The way the research has been conducted should be clearly indicated. This part is only interesting for those who wish to carry out a similar activity. That is why it should be as concise as possible. However it shall also include sufficient

elements to enable others to do the same work ("The paper of the century" on the cold nuclear fusion was rejected by the American Scientific Journal "Nature" just for this aspect). This part may often be shortened by giving bibliographic references when other authors have already described in detail some methods used.

III-2.3. "Results and Discussions", the subsequent part, is the substance of the paper. Both are most often jointly dealt with, aspect by aspect. However all results are sometimes given together (under the heading "Results"), followed by a separate general discussion (under the heading "Discussion"). Once the choice has been made the author should consequently stick to it. In any case, even in adopting the joint aspect by aspect presentation, all the results of one aspect must always be presented first before starting the discussion. Your attention is drawn to the fact that you have to discuss essentially your own results. The discussion is mainly aimed at stressing the scientific or practical significance of these results in relation to other published research work. When you make assumptions these should clearly appear in the text and in this case it is always advisable to support these assumptions with concrete observations or results found in scientific litterature. In addition you should comply with the rule according to which the reader should be able to perceive the text and each figure or table independendtly (see II-4 and II-5).

III-2.4. "Final Discussion and or Conclusion" is often an additional part which is not always indispensable. In any case, conclusions must be based on your own results and not on assumptions or results obtained by others.

III-2.5 Bibliographic references form the final portion of the paper. See written notes in II-6.

III-2.6 Length of Paper should not exceed 20 double-spaced pages including tables and references.

IV-OTHER INDICATIONS

IV-1. Footnotes should be generally avoided particularly when there are information which may be easily incorporated in the text. If this is impossible they must be indentified by arabic figures at the top, with continuous numbering in the whole text. Every footnote must be at the bottom of the page on which it is indicated.

IV-2. Formulae, units and conversions: In publications, only the metric unit measures and the symbols and common equations of the international system (I.S.) are used. Local measures can be mentioned only when the conversion to the I.S. is clearly explained in the text and also in figures and tables.

IV-3. Headings: authors are advised to use short and informative headings to subdivide long sections. They should be typed, underlined and written in small letters (except the first word). Subtitles may also be used but must not numbered. Subtitles should be avoided as much as possible.

IV-4. Abbreviations: The names of organizations and countries must be fully mentioned for a first time at the beginning but should be subsequently mentioned in the form of acronyms written in capital letters and without full stops (FAO, ARD). Other abbreviations shall be written in small letters and with full stops (u.l.v) but also fully written for the first time.

IV-5. Specification of pesticides, medecines etc. Commercial names shall be written in capital letters but when they are mentioned for the first time they must be followed by the common name(s) of the patent constituents such as accepted by the International Standards Organization (ISO). In the absence of the ISO name, the full chemical name shall be indicated. In the page of the first mention, the company of origin may be indicated by a footnote, e.g. PALUDRINE (*) (Proguanil).
(*) ICI commercial name.

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SYSTEMES AGRICOLES EN AFRIQUE

RECOMMANDATIONS AUX AUTEURS

I - GENERALITES

A - Politique Générale

1 - La Revue

Systèmes Agricoles en Afrique est une revue semestrielle multidisciplinaire qui publie en général des travaux originaux dans tous les domaines de la recherche sur les systèmes agricoles (systèmes de production, systèmes agraires) y compris les problèmes d'économie agricole au niveau local ou régional. Plus particulièrement, il publie:

- des articles de fond pouvant être des compte rendus originaux de recherche scientifique ou de brèves communications;

- des Actes de réunions scientifiques sur les systèmes agricoles;

- des articles faisant le point des connaissances actuelles sur un sujet donné.

2 - Public cible

Pour être accepté, un article doit s'adresser aussi bien aux chercheurs qu'aux cadres de la vulgarisation agricole et aux décideurs des politiques agricoles des pays de l'Afrique au Sud du Sahara, l'Afrique Occidentale ainsi que les autres régions de l'Afrique.

3 - Soumission des articles

Les manuscrits doivent être envoyés en trois exemplaires (l'original et deux copies) ou mieux, une disquette contenant le texte et l'original de l'article au rédacteur en chef. Dans ce dernier cas, les noms du logiciel, du fichier et des auteurs doivent être précisés. Des disquettes de 5"1/4 et 3"1/2 Haute ou Double Densité peuvent être utilisées.

4 - Langue de publication

Systèmes Agricoles en Afrique publie des articles rédigés en français ou en anglais. Le titre de l'article, le résumé, et les mots-clefs sont traduits dans l'autre langue.

B - Considérations particulières

- Le nombre des auteurs d'un article ne doit pas dépasser 4. Cependant, il est possible d'utiliser un nom collectif (comme par exemple, **Etude collective sur..**). Dans ce cas aussi, les noms des auteurs doivent être produits.

- *Systèmes Agricoles en Afrique* ne publie que des articles non encore publiés. Une fois acceptés pour publication, ces articles ne pourront être proposés à une autre revue qu'avec le consentement du rédacteur en chef de *Systèmes Agricoles en Afrique.*

- Publié dans *Systèmes Agricoles en Afrique*,le copyright des manuscrits appartient au RESPAO qui se réserve le droit de les publier ou republier sous une forme ou dans une langue de son choix.

- Les articles acceptés pour publication pourront faire l'objet d'une révision rédactionnelle qui peut aller jusqu' à une condensation du texte ou la suppression de tableaux et d'illustrations.

- Les auteurs doivent fournir toute autorisation nécessaire à la publication d'éléments bénéficiant d'un copyright qu' ils souhaiteraient inclure dans leurs articles.

II- LE MANUSCRIT

II- 1. Généralités: Le texte original et deux copies du manuscrit final doivent être envoyés au Journal. Le manuscrit doit être dactylographié ou imprimé sur papier bon blanc, format 21 cm x 27.7 de préférence, avec une marge d'au moins 4 cm pour les corrections. Il ne faut dactylographier que sur un côté seulement de la feuille. Toutes les parties du manuscrit doivent être dactylographiées à interligne double. Seuls les mots qui seront imprimés en italique doivent être soulignés.

La première page ne doit contenir que le titre, le nom de l'auteur ou des auteurs, leurs adresses complètes au bureau et toute note infrapaginale qui s'impose. La numérotation commence à la première page et englobe toutes les pages.

La première ligne de chaque paragraphe dans le texte et de toutes les légendes et notes infrapaginales doit commencer en retrait.

L'auteur doit vérifier le manuscrit une dernière fois avant la dactylographie finale.

II-2. Le Titre de la communication devra être court, mais refléter clairement son contenu. Il devra être suivi par les noms complets et les adresses des auteurs.

II-3. Le résumé: Les articles doivent être accom-

pagnés d'un résumé de 200 mots au plus, rédigé dans un style concis et clair, où le but, les résultats et conclusions principaux sont indiqués. Les auteurs qui le peuvent sont encouragés à présenter un résumé à la fois en bon français et en bon anglais. Les références ne doivent pas être mentionnées dans le résumé.

II-4. Le texte: Les articles doivent être écrits de façon claire et concise et ne doivent contenir que l'information essentielle. Le contenu du texte doit être compréhensible sans voir les Figures et les Tableaux.

II-5. Figures et Tableaux: Chaque Tableau doit avoir son titre et chaque Figure sa légende, ce qui permettra au lecteur de comprendre le contenu sans voir le texte de l'article. Les Figures et Tableaux doivent être numérotés en série (Fig. 1, Fig. 2,; Tableau 1, Tableau 2, etc.). Les tableaux (avec les titres) et les figures (avec les légendes) doivent être séparés du texte et placés à la fin du manuscrit, mais leur place dans le texte sera indiquée dans la marge du texte avec un crayon.

Les tableaux doivent être dactylographiés à interligne double.

Les figures seront tracées avec de l'encre noire sur papier blanc ou transparent, leurs dimensions seront environ le double de l'image dans l'article définitif. Les lettres dans la figure doivent être bien lisibles après la réduction. Il faut remettre des dessins aux traits originaux et deux séries de copies claires (pour des dessins simples, trois jeux de photocopies brillantes peuvent être acceptés). Pour fins d'identi-fication, il convient d'indiquer au verso de chaque figure ou tableau le nom du (des) auteur(s), le titre de l'article et le numéro du tableau ou de la figure.

II-6. Les références bibliographiques doivent être dactylographiées à interligne double et dans l'ordre alphabétique à la fin de l'article comme suit: nom et initiales de l'auteur; année de publication (distinguée successivement par les lettres, a,b, etc. ajoutés à la date si plusieurs publications sont citées du même auteur dans la même année); titre exact de l'article; nom complet du journal; numéro du volume en chiffre arabe, première et dernière page de l'article. Dans le texte, les publications doivent être citées avec le nom de l'auteur(s) avec l'année de la publication entre parenthèses p.e. (Koffi, 1986) ou Koffi (1986); Faye et Dubré (1988a,b). Pour les références avec plus de deux auteurs, on cite seulement le premier, suivi par "et al.", bien que dans la bibliographie tous les auteurs doivent être mentionnés. Les références d'autres sources que les journaux, p.e. les livres, devront inclure le nom de l'éditeur et le lieu de la publication. Chaque référence citée dans le texte doit apparaître dans la bibliographie et vice-versa.

III-INSTRUCTIONS SUR LA STRUCTURATION D'UN ARTICLE

La structuration d'un article sur un travail de recherche suit généralement le cheminement suivant:

III-1. Le résumé, avant la présentation du rapport, est surtout pour aider le lecteur, aprés qu'il l'aura lu, de prendre la décision soit de continuer à lire l'article soit de passer à une autre activité. Comme déjà dit le résumé ne doit contenir que l'essentiel, c'est à dire les principaux résultats et conclusions et parfois aussi le but principal du travail (souvent cela n'est pas indispensable).

III-2. Le texte même est subdivisé en sections:

III-2.1 L'introduction où l'auteur explique aux lecteurs (i) *pourquoi* il a commencé ce travail et (ii) quels étaient ses *objectifs*.

III-2.2 "Matériels et méthodes" ou "méthodologie": Il faut bien indiquer comment la recherche a été faite. C'est une partie seulement intéressante pour ceux qui veulent faire une activité similaire. C'est pour cette raison qu'elle doit être le plus concis possible, mais elle devra aussi contenir suffisamment d'éléments pour permettre à d'autres de faire le même travail ("L'article du siècle" sur la fusion nucléaire froide a été refusé par le journal scientifique américain "Nature" juste pour cet aspect). Souvent il est possible de raccourcir cette partie par des références bibliographiques, lorsque d'autres ont déjà décrit en détail certaines méthodes utilisées.

III-2.3 "Résultats et Discussion", la partie qui suit, c'est la substance de l'article. Les deux sont le plus souvent traités conjointement, aspect par aspect. Cependant parfois les résultats sont tous donnés ensemble (sous l'en-tête "Résultats"), suivi par une discussion générale séparée (sous l'en-tête "Discussion"). Une fois le choix fait, il faut rester conséquent envers ce choix. Et de toute façon, même en adoptant la présentation conjointe aspect par aspect, il faut toujours présenter d'abord tous les résultats d'un aspect, avant de commencer la discussion. Votre attention est attirée sur le fait qu'il faut discuter surtout ses propres résultats. Lorsque vous faites des suppositions, cela doit apparaître clairement dans le texte, et dans ce cas il est toujours bon de renforcer ces suppositions par des observations concrètes ou des résultats trouvés dans la littérature scientifique. Par ailleurs, il faut respecter la règle que le lecteur doit pouvoir percevoir le texte et chaque figure ou tableau de façon indépendante (voir II-4 et II-5).

III-2.4 "Discussion finale et/ou Conclusions" est une partie souvent ajoutée, qui n'est pas toujours indispensable. En tout cas, les conclusions doivent être toujours basées sur ses propres résultats, et pas sur les suppositions ou les résultats obtenus par les autres.

III-2.5 Les références bibliographiques sont la fin de l'article. Voir les notes écrites du point II-6.

III-2.6 La longueur de l'article y compris les tableaux et les références ne doit pas dépasser 20 pages à interligne double.

IV-AUTRES INDICATIONS

IV-1. Les Notes en bas de page devront généralement être évitées, surtout lorsqu' il s'agit d'information qui peut facilement être incorporée dans le texte. Si cela est impossible, elles doivent être identifiées par des chiffres arabes en position supérieure, avec numérotation continue dans l'ensemble du texte. Toute note infrapaginale doit figurer au bas de la page où elle est signalée.

IV-2. Formulaire, unités et conversion: Dans les publications, seuls les unités de mesures métriques et les symboles et équations usuelles du système international (S.I.). Les mesures locales peuvent être mentionnées seulement quand la conversion au S.I. est clairement expliquée dans le texte, et aussi les figures et les tableaux.

IV-3. En-têtes: Il est recommandé d'utiliser des en-têtes courtes et informatives pour subdiviser les sections longues. Elles devraient être tapées, soulignées et écrites en lettres minuscules (sauf le premier mot). Les *sous-titres* peuvent aussi être utilisés, mais ils ne doivent pas être soulignés et de préférence il ne faut pas les numéroter. Les *sous-sous titres* devraient être évités autant que possible.

IV-4. Abréviations: Les noms des organisations et de pays devront être complètement mentionnés une première fois au début, mais devraient ensuite être mentionnés sous forme de sigles écrits en lettres capitales et sans points (FAO, DRA, RFA). Les autres abréviations devront être écrites en lettres minuscules et avec des points (u.l.v.), mais elles aussi sont écrites entièrement pour la première fois.

IV-5. Nomenclature de pesticides, médicaments etc.: Les noms commerciaux seront écrits en lettres capitales, mais la première fois qu'ils sont mentionnés ils doivent être suivis par le(s) nom(s) commun(s) des ingrédients actifs, telle que accepté par "International Standars Organisation (ISO)". En absence du nom ISO, le nom chimique complet devra être donné. Dans la page de la première mention, la société d'origine peut être indiquée par une note en bas de la page, p.e. **PALUDRINE** (*) (Proguanil).

(*) Nom commercial d'ICI

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