African Rural Social Sciences Research Networks

ISSUES IN AFRICAN RURAL DEVELOPMENT

Winrock International Institute for Agricultural Development

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Steven A Breth, editor

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Contents

Foreword

A serious concern in Africa is the large gap between research and the real needs of the rural farmer or household The papers published in this collection represent efforts by African scholars to close that gap by tackling problems that are relevant to the needs of rural development as well as intellectually challenging The studies were carried out under the auspices of the African Rural Social Sciences Research Networks program (ARSSRN), sponsored by Winrock International

Since 1987 the ARSSRN program has brought together English-speaking and French-speaking researchers, women as well as men, providing a collegial mechanism for social science research, peer review, and professional exchange The published results have been made available to policy makers and researchers in Africa, Europe, and the United States

The formal objectives of the ARSSRN are to

- engage African scholars in policy-related research that contributes to understanding the social, environmental, and economic aspects of Africa's rural and agricultural development
- develop networks of social scientists to stimulate discussion and provide peer review of research
- publish and disseminate research findings and in particular to make relevant material available to researchers, policy makers, and institutions in Africa

Under its small grants program, the ARSSRN periodically invites African scholars to apply for research grants The ARSSRN advisory committee reviews the submissions and recommends outstanding proposals for funding The grantees receive technical, intellectual, and administrative support from advisory committee members during the course of their research In addition, the grantees are put in contact with participants from earlier rounds of the program, who can provide peer review and support The grantees are expected to produce a research paper covering their work Drafts are submitted to members of the advisory committee who make suggestions for improvement and ultimately recommend whether or not the paper should be published

The 13 studies in this volume are arranged by country and represent a wide range of social science fields and topics in African rural development All are based on primary field data and have policy implications Their authors represent institutions in eight countries The last section of the book contains translations of the summaries of the papers

This is the second volume stemming from research under the ARSSRN program The earlier book, *Issues in African Rural Development 1991*, contains 24 studies from six countries

Winrock International is grateful to the Ford Foundation and the United States Agency for International Development for their support of the African Rural Social Sciences Research Networks and their dedication to excellence in African research and human resource development Winrock is also grateful to the African Development Bank where the last peer-review workshop was held to review and exchange research experiences in African rural development

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La dynamique des activités de transformation et l'émergence d'un secteur de petites et moyennes entreprises agro-alimentaires rurales

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RESUME
Malgre son importance dans l'economie nationale, le secteur agro-alimentaire Beninois a connu ces dernieres annees des problemes structurels lies aux echecs cuisants enregistres dans la plupart des filieres industrielles ou d'exportation En revanche, les activites de transformations agro-alimentaires artisanales, considerees comme informelles et marginalisees, ont demontre leur dynamisme et leur grande capacite d'adaptation aux changements socio-economiques survenus dans le pays

Au regard de ce regain d'activite, notamment en ce qui concerne la fabrication du gari, le present travail a ete consacre, non seulement a l'etude du contexte de la structure et du fonctionnement des micro-entreprises concernees, mais aussi a l analyse de leurs performances puis aux conditions d'emergence d'un secteur des petites et moyennes entreprises agro-alimentaires rurales

Les enquêtes ont ete essentiellement menees dans trois sous-prefectures du Departement de l'Oueme caracterisees par l importance des activites de production et de transformation du manioc Au total, vingt-huit entreprises (dont vingt-cinq individuelles et trois collectives) ont ete couvertes par l'enquête Ces enquêtes ont ete completees par des entretiens avec d'autres operateurs de cette filiere, en particulier les commerçantes et les artisans locaux qui fabriquent les petits materiels et equipements

De cette etude, il ressort que pres de 90% des femmes de la zone se consacrent a la fabrication du gari La plupart des entreprises produisent elles-mêmes une partie de la matiere premiere, mais leur degre d'integration verticale et bien d autres caracteristiques telles que l'âge, l anciennete dans l'activite et le niveau d instruction de leurs chefs n ont pratiquement aucune influence sur les resultats obtenus On observe que les niveaux de productions et de revenus realises par les entreprises dependent essentiellement de leur capacite de production et des facilites d'acces au capital En d'autres termes les entreprises qui disposent d'un fonds de roulement suffisant et des infrastructures de stockage adequates obtiennent les meilleurs resultats

De façon generale, le fonctionnement et les niveaux de performance des entreprises reposent sur une bonne coherence entre l'organisation de l unite, son acces au capital, son environnement et les buts du chef d'entreprise

Ainsi par rapport aux groupements les entreprises individuelles paraissent plus performantes eu egard aux dynamiques d innovations enregistrees Celles-ci se rapportent essentiellement aux ameliorations technologiques portant sur les outils, le procede et les changements au niveau de l organisation sociale de la production du gari Malgre ces acquis a peine 25% des entreprises etudiees fonctionnent dans les conditions optimales de rentabilite C'est pourquoi l emergence effective d un secteur des petites et moyennes entreprises plus efficientes exige que des solutions soient apportees pour lever les contraintes et ce a travers la creation et le maintien d un environnement technologique et socio-economique plus favorable Dans ce cadre les mesures et actions a mettre en oeuvre porteront essentiellement sur le volet technologique et le volet infrastructure, avec au centre une politique de credit appropriee

Les agro-industries apportent une contribution importante au developpement economique d une nation et ceci pour plusieurs raisons (Austin 1981) Tout d abord grâce a elles une nation peut transformer ses produits agricoles a l etat brut en produits finis propres a la consommation Elles constituent ainsi la plus grande fraction du secteur manufacturier d une nation en developpement Ensuite les produits agro-industriels sont souvent les principaux produits d exportation d une nation en developpe ment et peuvent offrir aussi des possibilites de substitution a l'importation Enfin le systeme agro-alimentaire procure a la nation les elements nutritifs qui sont essentiels au bien-être d une population croissante

En egard a ces multiples rôles que jouent les agro-industries les strategies de developpement des pays moins avances s appuient generalement sur la promotion du secteur agro-alimentaire Mais dans le contexte de liberalisation economique actuel le modele de developpement agro-alimentaire base sur la creation d'entreprises centralisees et de grande capacite montre dans bien des cas, ses limites La plupart des instances politiques, de financement ou de recherche affirment aujourd'hui la necessite de definir des alternatives a ce modele L interet des micro-entreprises rurales est ainsi reconnu bien qu elles restent classees dans le secteur dit informel et sont marginalisees

Au Benin en particulier le secteur agro-alimentaire est domine par les activites de transformation artisanale Celles-ci sont realisees essentiellement au moyen d outils et de technologies mis au point localement et conduisent a une centaine de produits qui font l objet d un commerce florissant surtout dans les zones urbaines Le cas de la fabrication du gari (farine de manioc) apparaît tres important dans la mesure ou ce produit fait l objet de veritables speculations dans la quasi totalite du pays et meme dans la sous-region Tout comme bon nombre de filieres agro-alimentaires, la filiere gari enregistre par ailleurs des innovations tant sur les equipements et les procedes que sur les produits et l organisation sociale de la production et de la distribution faisant ainsi preuve de dynamisme et d une grande capacite d adaptation

Il apparaît donc necessaire aujourd hui de comprendre les bases techniques et socio-economiques de ces types d entreprises et d apprecier leurs performances La presente etude s inscrit dans ce cadre afin de proposer des orientations en faveur de la promotion du secteur des Petites et Moyennes Entreprises (PME)

Apres un expose succinct de la problematique, des objectifs et de la methodologie ce document presente les resultats obtenus puis analyse, sur cette base les conditions d emergence d un secteur des PME agro-alimentaires rurales avec un accent particulier sur les implications politiques que cela suggere

Problematique

Jusqu au lendemain des independances, la politique d industrialisation des pays du tiers monde a repose sur l installation de grosses unites de transformation et la mise en oeuvre de grands projets agro-industriels tres ambitieux parachutes' de l occident Cette orientation qui fut largement soutenue par les pays developpes, en leur qualite de vendeurs de technologie fournisseurs de capitaux et acheteurs de matieres premieres ou produits semi transformes a cree au niveau des pays du tiers monde un conflit entre la necessite de produire

des cultures vivrieres pour l'autosubsistance et le besoin d assurer un revenu substantiel, par la production des cultures industrielles ou d exportation C'est dans ces conditions que les filieres agro-alimentaires industrielles et/ou etatiques avaient ete longtemps developpees mais les echecs enregistres de part et d autre ont ete si nombreux et si patents que plusieurs etudes les ont denonce comme facteur de penurie alimentaire et de decouragement de l'agriculture paysanne[1]

Depuis lors, des reformes de politique technologique ont ete introduites dans la plupart de ces pays Au rang des objectifs retenus l accent avait ete mis sur la possibilite de relancer l agriculture par la transformation sur place des produits vivriers et de repondre a la demande urbaine en favorisant la fourniture de produits traditionnels C est ainsi que differentes approches innovatrices de technologie (intermediaire, appropriee, endogene) ont ete developpees, et ce, surtout, dans le cadre du passage d'une economie centralisee a une economie de marche caracterisee par la diminution du rôle de l Etat Dans ce contexte, la question se pose aujourd hui de savoir dans quelle mesure la dynamique induite au niveau des unites de transformation traditionnelles ou artisanales peut s entretenir d elle-même et se developper en faveur de l'emergence d'unites plus efficientes

Au Benin, cette question est d'autant plus importante que dans le domaine de l'agro-alimentaire, la strategie de developpement adoptee depuis 1990 — notamment apres le seminaire de Juillet 1990 a Cotonou sur la strategie du developpement rural — porte essentiellement sur le developpement d un secteur de petites et moyennes entreprises (PME) axees sur la transformation des produits vivriers En effet la quasi-absence de ces entreprises phenomene que l'on rencontre dans de nombreux pays africains, constitue une hypotheque pour l avenir du secteur agro-alimentaire

On est surtout frappe par le fait que ce secteur, tres heterogene et qualifie d informel, joue un rôle de plus en plus important dans l economie nationale[2] Même s'il reste encore mal connu, on observe que ce secteur met en jeu deux categories d entreprises les unites agro-alimentaires traditionnelles et celles promues par des projets de developpement Les premieres se sont developpees spontanement dans des conditions liees a l entrepreneur local et qui favorisent la creation individuelle de micro-entreprises rurales Les secondes ont ete installees et/ou encouragees dans des conditions liees aux changements de l'environnement, notamment grâce a l'appui technique financier, de partenaires exterieurs au monde rural

En egard a tout ce qui precede, et avec la vague de liberalisation et du desengagement de l Etat l'importance de l'enjeu n'en est pas moins considerable et oblige a reflechir sur des mesures d'accompagnement Mais quels pourraient en être les leviers ?

Revue de littérature

Les peuples ont toujours cherche a transformer les produits agricoles soit pour les rendre consommables, soit pour les conserver en evitant les pertes, ou encore pour promouvoir leur vente (Burne, 1988) Cette necessite se traduit par l'intensification des rapports entre l agriculture et l'industrie sous forme de systemes ou de complexes agro-industriels et d'agro-entreprises

Malgre le developpement des complexes agro-industriels partout ailleurs dans le monde les pays du tiers monde restent caracterises par la predominance des technologies alimentaires autochtones Principales heritieres, les femmes assurent la transformation des produits vivriers locaux — le plus souvent au prix d'enormes efforts physiques — et en degagent l'essentiel de leurs revenus Ces technologies constituent ainsi l'expression d une riche tradition culturelle et font montre d un grand potentiel de savoir-faire endogene

En effet, ni la colonisation, ni l'urbanisation, ni l industrialisation n'ont eu raison d elles et entraîne leur disparition (Nago, 1989) Au contraire elles ont reussi a se maintenir et mieux, certaines d'entre elles se sont developpees en offrant des produits et des services correspondant aux nouveaux styles de

[1]Van Looly (1981) Barbara et Dinham (1983) Williams et Karen (1985) L Malassis (1986) etc

[2]Alors que l industrie moderne represente a peine 10% du PIB l ensemble du secteur non structure (informel) ou predomine l artisanat alimentaire contribue pour plus de 40% a la formation de ce PIB Cette contribution se rapproche sensiblement de celle du secteur agricole estime a 44%

vie Ce qui entraîne souvent une modification de l organisation sociale de la production et de la distribution avec parfois l'apparition de nouveaux operateurs

Divers travaux sur les filieres de produits agricoles alimentaires et sur la structuration du secteur agro alimentaire dans les regions chaudes ont permis d identifier l'existence de petites et moyennes entreprises agro-alimentaires localisees en zone rurale decentralisees et proches des producteurs paysans Celles-ci sont gerees, soit par les producteurs eux mêmes (en general les femmes) individuellement ou collectivement, soit par les entrepreneurs prives ruraux non agriculteurs mais valorisant la production agricole locale[3]

Une premiere analyse de ce secteur menee par le laboratoire Systemes Techniques agro-alimentaires et Sciences de la Consommation (STSC 1953) et sur quelques cas specifiques a permis d'aboutir a quatre grandes conclusions provisoires

1 Tout d abord ce type d entreprise apparaît a premiere vue jouer un rôle important voire primordial dans le developpement agricole et rural de certains pays en termes d emplois et de revenus crees ces entreprises contribuent de façon tres significative au developpement rural,
2 En second lieu ces entreprises apparaissent comme des alternatives credibles aux grands projets industriels Dans le contexte de liberalisation economique actuel le modele de developpement agro-alimentaire base sur la creation d entreprises centralisees et de grande capacite montre, dans bien des cas ses limites,
3 La grande diversite des entreprises identifiees tient a differents facteurs tant economiques et sociaux que techniques Une typologie reste a construire mais on peut deja supposer que ces differents types d entreprises ont des strategies et des fonctionnements differents tant dans leurs relations avec le reste de la filiere que vis-a-vis de l environnement plus large
4 Enfin le fonctionnement et les strategies de ce type d entreprises presentent en premiere analyse des specificites compares a ceux des grandes firmes agro-alimentaires Leurs caracteristiques rendent d autant plus necessaire une approche qui prenne en compte le fait que ces entreprises deploient des strategies au sein de reseaux ou d organisations paralleles au marche (reseaux sociaux organisations paysannes, etc)

Ce type d analyse qui s appuie sur des travaux recents d economie de l organisation industrielle nous eclaire pour comprendre les logiques particulieres de ces entreprises (exemples prestations de service multiplication des unites plutôt qu'augmentation de la taille etc)

Si ces differentes observations traduisent en general l importance et la dynamique du secteur agro-alimentaire, il n en demeure pas moins important que par rapport aux pays d'Amerique latine la tendance en Afrique est moins nette et revêt des modalites variees (Treillon 1992)

Au Benin en particulier, beaucoup de produits agricoles sont transformes par des voies traditionnelles ou artisanales mais tres peu d etudes leur ont ete consacrees (Nago 1989 CNEX 1992) Le recensement des entreprises du secteur agro-alimentaire effectue par le Ministere de l industrie ne fait pas cas des transformations artisanales

Pourtant, force est de constater que la branche agro-alimentaire de l industrie beninoise est dominee par les transformations artisanales (Wankpo, 1990) Les statistiques montrent que durant la periode 1982-1988, la valeur ajoutee (VA) realisee par le secteur artisanal a tendance a être superieure a celle du secteur moderne[4] le secteur artisanal fournit 66% de la VA de l industrie entiere avec 49% provenant de l artisanat alimentaire tandis que le moderne fournit 34% de la VA dont 15% proviennent des industries alimentaires de ce secteur (Mamah 1991)

Le secteur artisanal joue donc un rôle assez important dans l economie nationale Mais malgre ses performances il ne permet pas encore d atteindre un seuil decisif de production

Aujourd hui avec le processus de liberalisation de l economie nationale et le desengagement de l Etat, les producteurs agricoles sont confrontes a

[3] DSA CIRAD SAR Conditions d emergence et de fonctionnement des entreprises agro alimentaires rurales Problematique et orientations methodologiques ATP CIRAD Laboratoire STSC fevrier 1993 P 3

[4] Le Benin Etude regionale et sectorielle dans les Marches Tropicaux no 2354 decembre 1990 p 83671

une situation d incertitude accrue, liee aux aleas du marche Pour ce faire, ils tentent de developper des strategies de diversification et de reduction des risques Les entreprises rurales de transformation et de commercialisation des produits agricoles offrent une solution possible (Treillon, 1992) Des lors, la dynamique et les performances des unites de transformations artisanales qui existent deja constituent certainement un facteur-cle pour l emergence de petites et moyennes entreprises agro-alimentaires plus efficientes

Objectifs et hypotheses

La presente etude vise principalement a comprendre le contexte, la structure et le fonctionnement des entreprises agro-alimentaires rurales puis a analyser les conditions technologiques et socio-economiques de leur emergence Les objectifs specifiques a atteindre sont

1 Analyser les caracteristiques socio-economiques des deux categories d'entreprises agro-alimentaires specifiees,
2 Comprendre le comportement de l entrepreneur, le fonctionnement de ces entreprises et les relations qu'elles entretiennent avec l environnement, puis comparer leurs performances,
3 Analyser les conditions et les structures actuelles qui favorisent le developpement de ces entreprises puis proposer des orientations en faveur de l'emergence d'un secteur des petites et moyennes entreprises plus efficientes

L idee maîtresse de l etude est que le rôle et l importance grandissants des unites agro-alimentaires traditionnelles ou artisanales engendrent une dynamique favorable a l'emergence des petites et moyennes entreprises et au developpement du secteur agro-alimentaire Ainsi, en rapport avec les objectifs cites ci-dessus cette etude repose sur les hypotheses suivantes

1 Le contexte organisationnel et les bases techniques sur lesquelles repose la production du gari ne favorisent pas le developpement des entreprises collectives,
2 Le degre d'integration verticale des entreprises a une influence positive sur leurs performances,
3 L'emergence du secteur des petites et moyennes entreprises en agro-alimentaire depend beaucoup plus des conditions liees a leur environnement socio-economique, que des facteurs intrinseques de l'acteur qui favorisent la creation (individuelle) d entreprises

Méthodologie

Choix du cas de la transformation du manioc en gari

Pour analyser la dynamique des activites de transformation artisanale et l'emergence d'un secteur de petites et moyennes entreprises agro-alimentaires plus efficientes, nous avons retenu la filière gari[5] Certes, les activites de transformation artisanale ne se limitent pas a la fabrication du gari Apres le mais et le manioc l arachide et le niebe fournissent aussi de nombreux derives, d'autres produits sont egalement transformes, mais dans une moindre mesure l'igname, le mil le sorgho, l'amande de coco, la banane, la noix de palme, le ble, la graine de karite, le vin de palme, etc (Nago, 1989) Mais sur le plan national, le gari represente le premier produit agro-alimentaire artisanal qui fait l objet d un veritable commerce En effet, l'aire geographique de la culture du manioc couvrant la quasi-totalite des regions du pays (en particulier le Sud et le Centre), sa production a atteint, ces dernieres annees des proportions tres importantes (voir tableau N°1) liees a une demande (locale et regionale) de son derive de plus en plus croissante

Une enquête realisee par le CARDER-Atlantique[6] sur les activites de transformation et de conservation des produits agro-alimentaires dans les villages du departement revele que tous les villages exercent au moins une activite de transformation Sur quatre vingt onze questionnaires remplis dans l ensemble de la region, 69 mentionnent la fabrication du gari comme etant l'activite la plus importante Le mais ne faisait pas partie du domaine de l enquête parce que ses produits derives ne se conservent pas bien

Ces resultats montrent, tout au moins en ce qui concerne le sud-Benin, une activite de trans-

[5]Le gari se presente sous la forme d un granule du manioc (type semoule de couscous) fermente et cuit a sec C est un aliment de base des populations du bassin du Benin
[6] Centre d Action Regional pour le Developpement Rural

Tableau N°1 Evolution de la production de manioc au niveau des six departements (en tonnes)

Départements	1961	1965	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991
Atacora	11 050	15 504	19 225	2 832	59 771	65 688	71 906	75 680	111 945	101 995	111 102	105 917
Atlantique	225 850	119 725	108 370	135 584	98 040	124 431	91 679	60 604	111 451	99 721	110 568	132 182
Borgou	41 285	39 120	34 640	15 927	31 125	43 153	48 463	37 461	52 741	60 641	57 215	64 696
Mono	128 850	143 900	136 800	37 625	76 137	118 569	143 778	73 851	132 080	126 076	105 499	121 469
Oueme	695 945	485 700	466 720	201 745	122 619	140 281	187 071	179 607	247 607	311 935	312 984	299 247
Zou	132 400	128 680	62 445	140 493	195 043	207 052	181 365	144 277	223 857	276 436	239 945	335 662
Total	1 235 380	932 629	828 200	534 206	582 735	699 174	724 262	571 540	879 681	976 804	937 313	1 059 173

formation intense et diversifiee La predominance de la fabrication du gari temoigne par ailleurs de l importance de ces types d entreprises dans tout le pays encore que ce departement occupe la quatrieme place pour la production de la matiere premiere a savoir le manioc (Cf tableau n°1)

Données recueillies

Par rapport aux objectifs vises a travers cette etude et en relation avec les hypotheses a tester les donnees recueillies sont essentiellement primaires mais de deux ordres

Les donnees qualitatives elles sont relatives d une part aux circonstances de la creation des entreprises leur evolution historique, puis au comportement — dans le temps — des chefs d'entreprises face a des situations critiques (difficultes economiques, mauvais fonctionnements techniques, conflits internes, problemes climatiques etc) D autre part ces donnees se rapportent a l organisation de l unite (division du travail recrutement type de remuneration croissance etc) son environnement (les concurrents et les relations entre differentes unites, l'amont et l aval de la production le financement, la gestion et les relations avec les pouvoirs publics) son activite (les connaissances pratiques les techniques utilisees et la nature du besoin satisfait) et les buts poursuivis par les chefs d'entreprises

Les donnees quantitatives elles portent notamment sur les caracteristiques socio-economiques des deux categories d entreprises leur structure leur fonctionnement (flux des matieres premieres des produits) et leurs resultats technico-economiques

Enfin les donnees relatives a l influence des relations de l'entreprise avec ses reseaux[7] sur les differentes fonctions de l unite ses performances et le comportement de son chef sont egalement recueillies

Cadre de l'etude

Au terme des investigations preliminaires, le departement de l'Oueme a ete choisi comme cadre d etude En effet, la fabrication du gari etant l activite retenue on observe que ce departement s est singularise par le volume et la qualite de sa production (ONC/Projet SECAL 1990)

Les enquêtes ont ete menees dans trois sous-prefectures (Adja Ouere Bonou et Ifangni[8]) representatives des differentes techniques de transformation utilisees dans ce departement

Choix des entreprises

Au niveau des trois sous-prefectures retenues l etude a porte sur un echantillon aleatoire stratifié de vingt cinq entreprises individuelles selectionnees dans les principales localites de production sur la base d'un tirage au sort elementaire et sans remise avec un taux de sondage de 20%

Le critere de stratification est la technologie utilisee le nombre d'entreprises dans chaque strate etant proportionnel a la taille de cette derniere

Dans la categorie des unites collectives fonctionnelles trois entreprises seulement (un groupement feminin par village) ont ete identifiees Eu egard a leur nombre tres reduit toutes les trois ont ete retenues d office

Au total, vingt huit entreprises ont donc ete couvertes par l enquête

[7]Un réseau peut etre defini comme toute forme d interdependance entre des elements unites ou sous systemes en relation les uns avec les autres

[8]Le choix de Ifangni se justifie surtout par le fait que dans le domaine des activites economiques et commerciales l influence technique et technologique du Nigéria (pays limitrophe de cette region) est bien marquee

Methodes de collecte des donnees

Les donnees ont ete recueillies en trois phases durant l'annee agricole 1992 et completees pendant le premier trimestre de l annee 1993

La premiere phase a couvert une periode de quatre semaines (au debut de la saison seche) durant laquelle une pre-enquête (a caractere exploratoire) a ete realisee en vue de recueillir les informations necessaires a l elaboration des questionnaires

La deuxieme phase a dure deux mois et a eu lieu en saison des pluies (periode d activites intenses de transformation), mais les informations recueillies ont porte aussi sur la saison seche (periode d activites reduites)

La troisieme phase, d une duree d'un mois, a ete consacree a des enquêtes d appoint qui ont permis de verifier et de completer les donnees recueillies lors de la phase precedente

Toutes les donnees ont ete recueillies a plusieurs reprises, selon le cycle de production et les periodes d activites et ensuite extrapolees sur toute l annee

Au moment même de leur collecte, les donnees ont ete validees grâce a des observations standardisees' realisees de façon systematique et des analyses documentaires effectuees exclusivement aupres des tresoriers des entreprises collectives qui disposent des cahiers de comptes, contrairement aux entreprises individuelles[9]

Methodes d'analyse des donnees

Les questionnaires remplis apres enquêtes ont ete traites sur ordinateur Les differentes variables relatives aux caracteristiques socio-economiques des entreprises ont d'abord ete resumees puis analysees sur la base des calcul des statistiques elementaires de position et de dispersion (moyennes, modes, ecart-type) Ces analyses a variable unique ont permis de decrire et de comparer la composition, la structure puis le fonctionnement des entreprises Elles ont ete completees par des analyses statistiques a variables multiples afin de comprendre les aspects technico-economiques de l activite des entreprises et les resultats obtenus puis de comparer leurs performances

Les informations qualitatives ont ete utilisees essentiellement pour mieux cerner les conditions et les structures actuelles qui favorisent le developpement de ces entreprises, leurs relations avec l environnement socio-economique et pour apprecier, en rapport avec la diffusion des innovations technologiques, les perspectives d'emergence d un secteur de petites et moyennes entreprises agro-alimentaires

Il existe plusieurs methodes pour apprecier les resultats d une entreprise[10] Dans ce cas precis ces resultats ont ete analyses surtout par rapport au niveau de la production realisee et au benefice degage

Sur la base des enquêtes realisees, il apparaît que plusieurs facteurs exogenes et endogenes influencent la performance des unites de transformation Mais a priori, toutes les variables mesurees ne peuvent pas être analysees dans une seule equation de regression a cause des problemes d'intercorrelation ou de multi-colinearite

Par ailleurs, eu egard au nombre eleve des variables et a la diversite des bases de mesure, la comparaison des variables ne sera pas aisee Pour cela, la technique d'analyse en composantes principales a ete utilisee afin de reduire d'abord les variables explicatives a quelques composantes essentiellement independantes[11] et d observer les ressemblances et dissemblances entre les entreprises[12] Elle a ete ensuite completee par l analyse de regression multiple Ce qui a permis de mieux apprecier les facteurs dont depend la performance de ces micro-entreprises

Les aspects technico-economiques des entreprises auraient pu être approfondis a partir de l'etablissement d un compte d'exploitation classique et de l'analyse des resultats comptables et techniques Ceci permettrait de mieux comparer ces entreprises sur la base de quelques ratios specifiques Il s'agit notamment

- du calcul de la valeur ajoutee pour la comparaison des dimensions economiques,

[9]Dans l echantillon seulement deux (2) entreprises individuelles tiennent des cahiers de compte et ont accepte de les laisser pour consultation

[10]A Mucchieli Les methodes qualitatives PUF collection que sais je? 1988 pp 66 70 et pp 102 103

[11] Kleimann et Kupper (1978) G Saporta (1978)

[12] G Philippeau (1988)

- de la repartition de la valeur ajoutee pour apprecier la structure productive
- des productivites du travail et du capital,
- de la rentabilite financiere resultat/chiffre d affaire
- du besoin en fonds de roulement fonds de roulement + liquidites
- le ratio de tresorerie (tresorerie nette/chiffre d affaire) x 360

Mais eu egard aux difficultes d adaptation de ces ratios a chacune des situations qui caracterisent l activite des entreprises ces elements d'appreciation ont manque En effet le contexte organisationnel de ces entreprises reposant d une part sur une logique d integration productive (couplage de plusieurs operations de la chaîne alimentaire) et d autre part sur une logique d integration sociale (aucune frontiere preetablie ne separe les activites productives des activites attachees a la vie en collectivite et de ce fait les reseaux de relations interpersonnelles jouent un rôle tres important) les criteres de prise en compte du travail familial ou de l entraide sont parfois tres differents et ne permettent pas d uniformiser les modalites de calcul Il en est de même pour d autres elements de gestion tels que l amortissement, le chiffre d affaire et les frais financiers C est pourquoi une plus grande attention a ete portee aux aspects qualitatifs de ces notions de gestion afin de partir de la façon dont les gens raisonnent dans la pratique la rentabilite et les performances de leurs entreprises

Résultats de l'analyse

Caractéristiques socio-economiques des entreprises

Dans la zone d etude la transformation du manioc en gari est la principale activite de pres de 90% des femmes Elles y tirent la quasi-totalite de leur revenu L agriculture, le petit commerce et le salariat representent leurs activites secondaires Le petit commerce et le salariat interviennent surtout en saison seche periode au cours de laquelle la matiere premiere coûte relativement chere

Au sein de l echantillon, 85 pour cent des productrices appartiennent a des menages agricoles tandis que le reste est represente par les femmes dont les maris sont des commerçants des artisans ou des fonctionnaires en retraite[13] ou non mais qui pratiquent l agriculture a petite echelle Leur âge varie de 21 ans a 50 ans avec une moyenne de 35 ans et 80 pour cent d entre elles sont analphabetes

Elles utilisent pour leur activite deux types de main-d'oeuvre

- La main-d oeuvre familiale constituee par la femme chef d entreprise elle-même, ses enfants (surtout les filles) et eventuellement d autres membres du menage restreint a l unite socio-economique de consommation de la fabricante On rencontre en moyenne deux actifs[14] par entreprise mais a cela s ajoute de façon ponctuelle ou reguliere la main-d oeuvre d aide ou d'entraide
- La main-d oeuvre salariee (temporaire), sollicitee pendant les periodes d intenses activites, est surtout utilisee pour l'epluchage du manioc et la torrefaction du moût presse (garification) qui sont des operations relativement difficiles[15]
- On peut compter en moyenne 3,8 actifs par entreprise et par cycle de production

Par rapport aux entreprises individuelles, les groupements sont caracterises par un nombre d actifs tres important (30 27 et 9 respectivement pour les groupements de Adja-Ouere Bonou et Ifangni) qui representent une main-d'oeuvre permanente Mais en general, les membres s occupent periodiquement de la même activite au niveau individuel Toutefois, la difference fondamentale entre ces deux types d'entreprises reside dans la façon dont le travail est organise

En effet, au niveau des entreprises individuelles, c'est le chef d'entreprise qui assure toutes les fonctions liees au processus de production et represente le seul centre de decision Le plus

[13] Dans cette categorie il y a les fonctionnaires qui ont quitte la fonction publique dans le cadre du programme des departs volontaires

[14] Ici un actif designe tout membre de l unite de production de gari de sexe feminin et d age superieur a 14 ans et qui s occupe principalement de cette activite

[15] Dans la plupart des cas le rapage mécanise a remplace le rapage manuel qui est plus difficile et de loin que les autres operations

souvent, les femmes consacrent en moyenne 5 jours par semaine aux activites de transformation La journee de travail va generalement de 7 heures a 18 heures soit en moyenne 10 heures par jour Dans la plupart des cas ces activites se font de façon continue (sans periode morte) durant toute l'annee en temps normal

Au niveau des groupements, l'organisation du travail apparaît plus efficace car les tâches sont souvent executees en equipes de trois a six personnes qui se relaient a tour de rôle Ainsi, la duree du travail journalier est relativement courte et n excede generalement pas huit heures, avec au plus cinq jours ouvres par semaine Ce qui permet a chaque membre de disposer du minimum de temps necessaire pour repondre aux obligations menageres et eventuellement a l execution d'autres activites lucratives personnelles, dont notamment la fabrication du gari au niveau individuel

Des lors, on peut s interroger sur la question de savoir comment developper effectivement et plus efficacement une telle action collective, aupres d une population toute entiere, et qui s adonne a une speculation individuelle vendre son produit au meilleur prix Mais, le moins qu on puisse dire est que ces caracteristiques socio-economiques, et en particulier, l organisation du travail au sein de ces differentes entreprises ont une influence considerable sur leur fonctionnement

Modes de fonctionnement des entreprises

Le système des approvisionnements

Le systeme des approvisionnements met en jeu un ensemble de facteurs qui determinent les conditions d'acquisition de la matiere premiere et d autres intrants secondaires (l eau, le bois de chauffe, le petit materiel) Les facteurs les plus importants sont la periode d'activite et le fonds de roulement propre de l entreprise

En effet, la succession des saisons agricoles permet de definir deux periodes d'activites

- La premiere periode, celle des activites intenses, qui couvre les deux saisons pluvieuses et une partie de la saison seche Elle s'etend sur huit mois (d'avril a novembre) et est caracterisee par une abondance de la matiere premiere sur le marche local a un prix relativement bas (en moyenne 8 F CFA le kilo)
- La deuxieme periode qui dure quatre mois (de decembre a mars) est caracterisee par des activites de transformation moins importantes En effet, elle coincide avec la grande saison seche durant laquelle la recolte du manioc est tres difficile, ce qui limite considerablement les quantites offertes Durant cette periode, la matiere premiere coûte en moyenne 12 F CFA le kilo

Dans les menages non agricoles, les transformatrices achetent la matiere premiere sur le marche local ou directement chez les producteurs avec ou sans convention prealable et en assurent le transport[16]

Au niveau des menages agricoles, il se produit une cession interne qui varie de 30 a 60% de la quantite totale de matiere premiere transformee Les femmes assurent elles-mêmes une partie de cette production (parfois plus de la moitie) et le reste leur est vendu par le mari Le complement est achete a l exterieur comme c est le cas avec les menages non agricoles Cette forme d integration en amont se retrouve egalement au niveau des 3 entreprises collectives enquêtees

D'une maniere generale, les approvisionnements se font sur place ou dans un rayon de 5 Km environ même en saison seche Mais, le coût de la matiere premiere varie suivant la quantite achetee, le lieu d approvisionnement et le mode d'achat Les entreprises qui achetent des quantites importantes et a des endroits plus eloignes des centres beneficient d'un prix relativement interessant Il en est de même pour celles qui disposent d un fonds de roulement propre suffisant pour assurer un achat au comptant[17]

Le système de transformation

Les operations de transformation commencent dans les 24 heures qui suivent l achat de la matiere premiere car, au bout de 2 ou 3 jours, celle-ci se gâte Les entreprises qui ne disposent pas d'equipements paient les services de rapâge-

[16] Le transport s effectue le plus souvent par automobile ou par poussette

[17] Environ 55 pour cent des entreprises privees achetent a credit alors qu au niveau des groupements les achats se font toujours au comptant

pressage effectues sur place par d autres entreprises ou operateurs La duree du cycle de production varie de 2 a 5 jours pendant la premiere periode et est legerement plus reduite au cours de la seconde Les entreprises individuelles transforment en moyenne 384 kg et 288 kg (par cycle) respectivement pendant la 1ere et la 2eme periode alors qu au niveau des groupements, la moyenne des quantites transformees est 3 ou 4 fois plus importantes

Cette transformation artisanale amelioree est plus developpee a Ikpinle (Adja-Ouere) que dans les autres localites[18] Deux operations sont mecanisees le râpage et le pressage Le rendement de la transformation est de l ordre de 20 pour cent et atteint en moyenne 22 pour cent durant la deuxieme periode car en ce moment la teneur en eau du manioc diminue en faveur de la concentration du fecule La quantite de gari produite par cycle est en moyenne de 75 kg pour la premiere periode et 60 kg pour la deuxieme periode au niveau des entreprises individuelles

Ces productions correspondent en moyenne au quart de celles realisees par les groupements La plupart des materiels utilises dans ce cadre sont de manufacture locale, en dehors de la rape a moteur et de la presse qui proviennent du Nigeria ou des centres urbains comme Porto-Novo et Cotonou L acquisition de ces deux equipements est limitee a ceux qui en ont les moyens Cela tient a deux raisons d une part il y a manque d information sur le systeme de credit formel pratique par la caisse locale de credit agricole mutuel (CLCAM), ce qui cree une barriere psychologique aupres des femmes et d autre part les taux pratiques par les usuriers sont tres eleves

Globalement deux qualites de gari sont produites La premiere qualite appelee ahayoe plus fine et plus conservable est destinee au marche exterieur alors que la seconde, produite en quantite moins considerable, est surtout vendue localement L importance de la production du gari de premiere qualite remonte au fait que la fabrication du gari pour la consommation familiale est encore tres repandue dans les villages (Même les membres des groupements en fabriquent pour la consommation du menage)

Le systeme de commercialisation

La commercialisation du gari dans les trois zones de production est caracterisee par la presence d un petit marche de collecte dans chaque localite et l absence d un commerce inter-villageois regulier Les marches s animent tous les quatre jours et reçoivent les commerçants qui viennent des regions de Cotonou ou de Porto-Novo et acheminent le gari vers les marches urbains (Dantopka a Cotonou et Ouando a Porto-Novo)

La plupart des entreprises individuelles livrent le produit sur les marches locaux Mais quelques-unes, de par la qualite et surtout la presentation (soins et emballages) de leur produit beneficient d une clientele reguliere qui negocie souvent a l avance la quantite desiree le jour du marche suivant Ainsi ces entreprises effectuent la vente au lieu de production et sont donc avantagees, en ce qui concerne les coûts de transport vers le marche du village

D une maniere generale, la vente s effectue des que le produit est transforme C est la preuve que la demande est assez importante, surtout en saison seche ou les quantites offertes sont relativement faibles Pendant cette periode le prix d une bassine de 30 kg de gari, varie de 2 000 a 2 500 F CFA (soit une moyenne de 75 F le kilo) alors qu il est de l ordre de 1 500 a 2 000 F CFA (en moyenne 60 F le kilo) en saison pluvieuse

On note par ailleurs que les cas d inondations enregistrees en saison pluvieuse dans les autres regions de production (Zou-Nord et Mono) entraînent aussi une augmentation periodique tres considerable de la demande Certaines entreprises s'efforcent de profiter de ces situations en augmentant leur niveau de production Cependant elles n en tirent pas souvent le benefice optimum car, les prix d'achats proposes par les commerçantes qui s entendent tres bien sont tres peu remunerateurs En effet, le pouvoir de negociation des productrices par rapport aux commerçantes est tres faible si bien qu elles sont finalement des preneuses de prix Elles se plaignent souvent de l agressivite de ces dernieres (surtout celles qui

[18] Contrairement aux autres regions on compte a Ikpinle plus de 10 ensembles (rape + moteur + presse) Vingt cinq (25) pour cent de ce materiel appartient a des hommes qui interviennent dans la filière comme prestataires de services et repondent aux besoins pressants des transformatrices qui ne disposent pas de materiel

viennent de Porto-Novo) qui embrassent exagerement la mesure locale utilisee A cela, il faut ajouter le manque d'infrastructure de stockage et la faiblesse du fonds de roulement propre qui les obligent a vendre leurs produits a des prix defavorables, au risque de suspendre periodiquement leurs activites

A priori, on peut envisager pour ces entreprises une integration vers l'aval Mais, dans la realite, cela n'est souvent pas pratique a cause du manque de moyens de transport et de l'etat des voies de communications En outre, un emploi du temps deja surcharge et le manque de moyens financiers constituent des contraintes pour la commercialisation du gari par les productrices-mêmes dans les marches urbains lointains

Les logiques de comportement des chefs d'entreprises et les resultats strategiques

Au niveau des entreprises individuelles couvertes par l'enquête, on remarque que les comportements des chefs d'entreprises ne sont pas systematiquement guides par la maximisation du profit En realite, il y a une juxtaposition de logiques marchande, technologique etc (approche complexe E Morin, D Genelot)

Chacune de ces logiques ou modes de coordination correspond a des principes qui determinent la prise de decision, suivant les differents contextes de fontionnement (l organisation de l'unite, la production, son amont et son aval)

Ainsi, les chefs d entreprises accordent generalement une priorite a l'utilisation de la main-d'oeuvre familiale (logique domestique ou sociale) surtout pour les operations qui demandent peu ou pas de technicite (epluchage et lavage de la matiere premiere, approvisionnement en bois de chauffe etc) Par contre, pour les operations telles que la cuisson ou le grillage (garification") dont depend la qualite du produit final et qui requiert un minimum de savoir-faire, ils recourent a une main-d oeuvre salariee' assez specialisee (logique technologique) afin d offrir sur le marche un produit qui repond aux exigences de la clientele et s'assurer des entrees d'argent minimales (logique marchande)

Suivant cette rationalite, la decision prise n est souvent pas la meilleure possible en termes des resultats attendus En effet, dans la plupart des cas, les chefs d'entreprises sont conscients que, en dehors de leur propre contribution, la productivite de la main-d'oeuvre familiale est relativement faible par rapport a celle de la main-d oeuvre salariee qui ne peut echapper au contrôle du chef d'entreprise

Mais puisqu'ils n'incorporent pas le coût du travail familial dans leur calcul de rentabilite, et aussi pour des raisons de manque de fonds de roulement, ils se contentent de la solution permettant d'atteindre une satisfaction minimale plutôt que d'engager a plein temps un ou deux employes Ainsi, la main-d oeuvre est payee a la tâche Cette rationalite est d autant plus soutenue que même en saison seche ou la demande du gari est tres forte et le coût de la main-d oeuvre relativement faible, les chefs d entreprises qui ont plus de moyens n'en profitent pas toujours pour intensifier leur production et elever leur niveau de revenu

En somme, s il est vrai que selon les cas, le chef d'entreprise se situe dans une logique ou une autre, la logique domestique apparaît souvent comme determinante dans les resultats obtenus, compte tenu de l'incertitude regnant dans les autres domaines et plus particulierement a propos des prix Au demeurant, la disponibilite d un fonds de roulement et son importance influencent aussi bien la prise de decision, les resultats strategiques et les performances des entreprises

Les performances des entreprises

Dans tous les cas etudies, le gari est produit d'une maniere artisanale dans une petite entreprise qui depasse le niveau familial de fabrication, etant presque uniquement destine a la commercialisation Mais sur le plan economique, les notions classiques d'emploi, de productivite, de valeur ajoutee, etc ne sont pas tres appropriees pour interpreter la realite de ces petites unites de production Un effort de comprehension de la façon dont ces femmes considerent les performances de leur unite (comment calculent-elles leur prix de vente, etc) a donc ete necessaire Sur cette base, un essai de quantification de quelques concepts a ete fait, a

Tableau n°2 Analyse en composantes principales sur donnees centrees reduites (Matrice de correlations)

Diagonalisation
1ème ligne Valeurs Propres (Variances Sur Les Axes Principaux)
2ème ligne Contribution a la variation totale (pourcentages expliqués par les axes principaux

	Axe 1	Axe 2	Axe 3	Axe 4	Axe 5
	4 1895	2 0715	1 8839	1 5935	1 0292
	29 9 %	14 8 %	13 5 %	11 4 %	7 4 %

Variables supplementaires

	Axe 1		Axe 2		Axe 3		Axe 4		Axe 5	
YI	0 7910	0 6257	0 1071	0 0115	0 0488	0 0024	0 4699	0 2208	0 2464	0 0607 *
QT	0 8607	0 7408	0 0779	0 0061	0 0951	0 0091	0 1659	0 0275	0 2675	0 0715 *

partir des recits des femmes et des observations realisees sur le terrain afin de bien cerner les variables qui expliquent le niveau de performance des entreprises en utilisant deux instruments d analyse l analyse en composantes principales et l analyse de regression

Analyse en composantes principales

Quatorze des variables quantitatives originales ont ete jugees pertinentes et prises en compte dans une analyse en composantes principales sur donnees centrees-reduites (matrices des correlations) Elles se definissent comme suit

Var 0 = prix unitaire de la matiere premiere pendant la première periode
Var 1 = prix unitaire de la matiere premiere pendant la deuxième periode
Var 2 = capacite maximale de production par cycle
C R P = cout rapage — pressage par cycle de production
C B = cout du bois p ir cycle de production
C F = cout de l eau
C M I = cout annuel materiel et equipement
C T 1 = cout du tr insport de la matiere premiere par cycle de production
AgX7 = age du chef d entreprise
IFRX6 = indice de fonds de roulement propre
AnX5 = ancienneté du chef d entreprise dans l activite
MTX2 = main d oeuvre salariee utilisee par cycle de production (en unite d actifs)
NIX9 = niveau d instruction du chef d entreprise
DTE = nombre d heures de travail par jour dans l entreprise

Ensuite deux variables supplementaires QT (production annuelle de gari par entreprise) et YI (benefice annuel degage) ont ete introduites comme variables a expliquer et de ce fait ne participent pas a la construction des axes principaux

Par ailleurs deux autres variables qualitatives VM (variete de manioc utilisee) et TE (type d'entreprise) ont ete prises en compte dans l analyse lors de la codification des individus

Tout ceci a permis d'observer de façon objective les liaisons avec les variables actives et de comparer les entreprises entre elles

Les resultats montrent que cinq composantes principales suffisent pour representer 77 pour cent soit plus des 3/4 de l information initiale et ont chacune une valeur propre superieure a 1 (tableau N°2)

Le premier axe met en evidence la liaison entre CME, Var2 CRP et CB et traduit le niveau d utilisation du capital Sur la base des correlations respectives de YI (0,79) et QT (0,86) avec cet axe, on note que ces variables sont bien expliquees par les variables representees par le plan principal

Le second axe qui est represente par IFRX6 et Var 0 traduit le degre d integration verticale des entreprises et plus precisement leur niveau d'articulation avec l'exploitation agricole Mais cela n influence pratiquement pas la quantite produite, ni le benefice realise

Les trois derniers axes traduisent respectivement l experience de l'entreprise dans le domaine, sa localisation et la periode d activite mais expliquent tres peu les variations de la production et du revenu

Par ailleurs, la repartition des entreprises dans le plan principal montre que la plupart des entreprises individuelles ont des caracteristiques voisines sauf quelques-unes qui disposent de leur propre equipement Cependant les groupements (entreprises collectives) ne se ressemblent pratiquement pas, ce qui tient plus au fait que l effectif de leurs membres differe sensiblement et de plus, qu une d entre elles ne possede pas d equipement ameliore

On observe egalement que la variete de manioc utilisee (variable qualitative) influence tres peu les

Tableau N°3 Resultats des modeles complets de regression multiple avec "Le benefice realise (1) et "La production" (2) des entreprises comme variables dependantes

Estimation des equations de regression							R^2	F
YI =	225372 +	19645X1	37100X2	51667X3 -	170707X4 +	32X5	0 84	23 8
		(86 78)	(1 52)	(2 56)	(25 22)	(0 69)		
QT =	15321 +	8090X1	872X2	1549X3	2353X4 +	0 X5	0 80	16 19
		(74 80)	(0 428)	(1 168)	(2 44)	(0 28)		

X1 = niveau d utilisation du capital X2 = degré d intégration verticale des entreprises (niveau d articulation de l entreprise avec l exploitation agricole) X3 = expérience de l entreprise dans le domaine X4 = localisation de l entreprise X5 = periode d activite

Les nombres entre parenthèses indiquent les valeurs de la statistique F pour les coefficients des variables P≤0 01

niveaux de production et de revenu realises Cela s'explique certainement par le fait que les entreprises ne choisissent pas exclusivement l'une ou l'autre des varietes locales ou ameliorees Il semble qu'un test du rendement de la transformation pour differentes varietes, permettrait de tirer des conclusions plus judicieuses

Analyse de regression

Sur la base des resultats precedents les deux variables supplementaires (le benefice YI et la production QT) ont ete utilisees comme variables dependantes dans plusieurs analyses de regression multiple pour approfondir les interpretations Les modeles specifies s ecrivent

$$YI = f(X1\ X2\ X3\ X4, X5\ U)$$

$$QT = f(X1\ X2, X3\ X4, X5, U)$$

ou X1 a X5 designent les cinq composantes principales extraites dans l'analyse precedente et U le terme d'erreur

Les equations lineaires, semi-logarithmique et double-logarithmique ont ete essayees dans des modeles complets Compte tenu des valeurs du coefficient de regression multiple adapte, du test des coefficients des variables independantes et de la conformite de leur signe avec les previsions empiriques, les resultats du modele lineaire qui apparaît plus performant ont ete retenus et sont indiques dans le tableau N°3

Dans le premier modele qui explique 84 pour cent des variations du benefice realise, deux des variables — le niveau d'utilisation du capital (X1) et la localisation de l'entreprise (X4) — ont des coefficients tres significatifs (seuil de 1 pour cent), mais de signes contraires Les autres variables explicatives (degre d'integration verticale des entreprises, leur experience dans le domaine et la periode d'activite) ne donnent pas de coefficients significatifs

Le second modele explique 80 pour cent des variations de la production des entreprises, mais c'est seulement la variable X1 (niveau d utilisation du capital) qui a fourni un coefficient significatif a un seuil de 1 pour cent

Ces differents resultats qui d ailleurs se completent, traduisent que la dimension des entreprises et leur proximite au village influencent positivement leur benefice Ainsi, en dehors de leur localisation, les entreprises ayant une grande capacite technique de production et disposant d un fonds de roulement plus important realisent les meilleurs niveaux de production et de revenu

En effet, bien que les entreprises situees pres des fermes agricoles soient mieux placees pour avoir une plus grande capacite de production (a cause des facilites d approvisionnement en matiere premiere a vil prix) elles sont malheureusement defavorisees dans la mesure ou l'acces a l'equipement ameliore est souvent difficile et, de surcroît, l'ecoulement du produit fini vers les marches de collecte coûte cher, ce qui reduit considerablement leur marge beneficiaire

On observe effectivement que dans le tableau N°4 qui presente la repartition par classes des entreprises suivant le benefice realise par unite de produit (BUP), les quatre entreprises qui ont les

Tableau N°4 Repartition des entreprises suivant le benefice realise par unite de produit

	Groupements		
Departements	Nombre	Effectifs (total)	Effectif (moyen)
Atlantique	5	82	16
Mono	8	155	20
Ouemé	6	87	14
Zou	13	281	22

Source GTZ/ONC 1990 Etude sur la securite alimentaire au Bénin n 5

BUP les plus eleves correspondent a des unites situees au village pres des marches de collecte (primaire) du produit et qui vont s approvisionner en matiere premiere dans les fermes environnantes

En dehors de ces aspects technico-economiques, les resultats strategiques obtenus correspondent au degre de satisfaction des buts sociaux (integration dans les reseaux) et personnels du chef d entreprise (liberte de gestion du benefice par la femme) Ainsi ces chefs d entreprise jugent que leurs entreprises sont performantes dans la mesure ou elles degagent au jour le jour les liquidites qui leur permettent de faire face aux differents besoins sans pour autant se soucier du developpement du capital fixe Mais leur degre de satisfaction reste generalement limite par leur pouvoir de negociation par rapport aux commerçantes

Au demeurant l initiative d une organisation sociale autour de laquelle les productrices pourraient s unir et resister aux marchandages abusifs des commerçantes existe mais merite d'être concretisee

En somme le benefice annuel moyen obtenu de cette activite est egal a 233 060 F CFA soit environ 20 000F CFA par mois Les entreprises les plus efficientes realisent jusqu a 2 000 000 F CFA par an soit en moyenne plus de 160 000 F CFA par mois Même si ces benefices sont a repartir entre la main-d oeuvre familiale, tous ces chiffres sont a comparer avec le revenu agricole et surtout le salaire mensuel brut d un ouvrier du secteur agro-alimentaire industriel qui est de l ordre de 20 000 F CFA au moment de l etude Il apparaît donc que les activites de transformation jouent un rôle tres important dans l economie des menages Le fonctionnement et les niveaux de performances des entreprises reposent sur une bonne coherence entre l organisation de l unite son acces au capital son environnement et les buts du chef d entreprise

Les dynamiques d'innovations et leurs impacts sur les activités des entreprises

L analyse historique de la production de gari dans la region revele que jusqu au debut des annees 70 tres peu de femmes maîtrisaient la technologie La production se faisait au niveau individuel et etait destinee presqu exclusivement a l auto-consommation Mais de plus en plus, ce produit a depasse le cadre du systeme des parentes, ce qui a facilement repandu sa consommation

Avec le passage progressif de l economie de subsistance a l'economie de marche, le gari est apparu comme l'un des principaux produits pour lesquels les femmes operent tout au long de la filiere et jouissent d une autonomie de gestion Cette situation a entraîne bon nombre de femmes dans ce secteur d activite sans pour autant susciter des initiatives endogenes de travail collectif ou de regroupement En effet les plus anciens groupements de femmes n ont commence a produire du gari que par simple reconversion d activites Le cas le plus significatif de cette reconversion est celui du groupement de Itchangni Monte en 1972 par l ex-SONADER[19], les adherentes produisaient de l huile de palme Mais tres tôt elles ont beneficie du concours financier de cette institution et se sont lancees dans la fabrication du gari Le produit dont la qualite est tres appreciee etait livre a la societe Amicale Coop qui le revendait aussi bien a l interieur qu'a l exterieur du pays

Ce debouche permanent assure par la SONADER avait permis au groupement d avoir une renommee et de connaître une dynamique qui n'a malheureusement pas pu s entretenir d elle même En effet, apres avoir ete rattache a la SOBEPALH[20] le groupement a eu des problemes de gestion et a perdu sa reputation

Ce cas illustre assez bien le cheminement de la plupart des structures a caractere cooperatif animant le travail feminin en milieu rural Souvent initiees par des agents exterieurs au monde rural leur efficacite est generalement liee a un processus institutionnel correspondant a l'intervention du secteur public dans l activation d une politique de demande qui en realite ne correspond pas a la demande sociale

Plusieurs facteurs expliquent l importance actuelle de la production de gari dans la zone D'une part, il y a l'influence des groupes ethniques Yoruba et Goun assez representes et qui consomment beaucoup de racines et tubercules ainsi que leurs derives (cossettes et gari) D'autre part, en raison de sa facilite de consommation le gari est

[19] Societe Nationale de Developpement Rural
[20] Societe Beninoise de Palmier a Huile

devenu le repas qui s'accommode le mieux aux activites commerciales par ailleurs tres intenses dans la region Mais cette situation a surtout ete catalysee par l influence technique et technologique du Nigeria sur la production alimentaire dans cette region

En effet, la diffusion des varietes de manioc a haut rendement[21] mis au point par l'Institut international de l'agriculture tropicale (Nigeria) a propulse le departement de l'Oueme au rang de premier producteur national depuis 1984 En 1989, l'Oueme seul a fourni 30 pour cent de la production nationale de manioc Cet essor dans la production de matiere premiere a ete systematiquement suivi par la diffusion des innovations portant a la fois sur l'outil et le procede, la qualite du produit et l'organisation sociale de sa filiere

La presse mecanique et la râpeuse actionnee par un moteur Diesel ou a essence se substituent progressivement aux outils traditionnels et permettent ainsi de realiser la mouture et le pressage plus rapidement et avec moins de peine sans augmenter les pertes Cette mecanisation partielle favorise ainsi un accroissement important du rendement horaire qui passe de 30 kg de manioc epluche par heure par personne (operation manuelle) a 700 kg de manioc par heure par personne (operation mecanique) Qui plus est, cela permet d'obtenir un produit tres fin, et plus sec, autant de caracteristiques recherchees par les consommateurs

Depuis quelques annees, les artisans locaux s inspirent de ce qu'ils ont vu au Nigeria ou de ce qui a ete introduit spontanement dans le milieu pour fabriquer a petite echelle des presses et des râpes mecaniques Mais malgre les facilites d'approvisionnement en carburant, le coût de l installation d une unite complete (y compris le moteur thermique) n'est pas a la portee de la plupart des productrices Cependant quelques-unes, avec leurs propres moyens ou l aide de leur mari se sont equipees De plus, les proprietaires de moulin a mais en profitent pour coupler une râpe et un moulin sur le même moteur thermique

L'occurence de chacune de ces alternatives a eu pour consequence l'intensification de cette activite, la proliferation des entreprises locataires ' de service et l'apparition des hommes (proprietaires d'unites de prestations de services ou salaries) dans une filiere traditionnellement maîtrisee en totalite par les femmes

Toutefois, les productrices qui sont dans les zones frontalieres et qui ne disposent pas d'equipement personnels transportent leur manioc frais dans une localite voisine du Nigeria ou elles transforment la matiere premiere et ramenent le gari sur le marche beninois Cette situation cree une confusion certes profitable aux consommateurs sur le marche du gari

Il faut noter que c'est dans ces conditions que, tout comme les autres groupements celui d Itchangni, relance par le CARDER en 1985 avait beneficie particulierement du soutien financier du Fonds d aide aux initiatives a la base et de l appui institutionnel de l'Organisation nationale pour la promotion des activites de la femme rurale pour l'installation d'une unite complete avec les infrastructures necessaires Cependant, sa performance reste limitee a cause des difficultes de gestion et de l'incapacite de renouveler les equipements

En somme, les dynamiques d'innovations enregistrees dans ce secteur d'activites ont joue un grand rôle dans le developpement et l'emergence des entreprises individuelles Quant aux entreprises collectives, leur etat d'avancement sur le plan organisationnel et dans le domaine de la gestion gêne leur possibilite de transposition, et surtout parce que la plupart d'entre elles sont nees grâce a l'intervention du secteur public dans la promotion d'une politique de demande en equipements ameliores

D apres le tableau N°5, on remarque evidemment, surtout pour le cas specifique du departement de l Oueme, que l'effectif des membres des groupements feminins est relativement faible Ceci tient au fait que les services dont elles peuvent beneficier dans ces structures leur sont vendus a peu de frais par des tiers qui installent râpes et presses mecaniques dans les localites de forte production Même au niveau des unites individuelles de production, de tels investissements sont de plus en plus realises

[21] Certaines localites enregistrent des rendements de l ordre de 20 tonnes par hectare alors que la moyenne nationale oscille entre 7 et 9 tonnes

Conclusion et recommandations

Les activites de transformation agro-alimentaire jouent effectivement un rôle important dans l economie des menages Le cas des entreprises de fabrication du gari montre que, grâce aux ameliorations technologiques enregistrees, ce secteur est devenu plus dynamique et constitue une veritable source d emplois, de revenus, et d aliments peu coûteux

Pres de 90 pour cent des femmes s occupent de cette activite en raison de l importance de la production du manioc dans la region La plupart des entreprises sont integrees vers l'amont et assurent une partie de l'approvisionnement en matiere premiere mais leur niveau d articulation avec l exploitation agricole n influe pratiquement pas sur les resultats obtenus Il en est de même pour l'âge l'ancienne te dans l'activite et le niveau d instruction des chefs d entreprises

Les niveaux de production et de benefice realises dependent essentiellement de la capacite de transformation des entreprises et de leur facilite d acces au capital Ainsi la faiblesse des fonds de roulement et le manque d'infrastructure de stockage assujettissent les productrices aux strategies mercantiles de leur clientele Mais globalement le fonctionnement et le niveau de performance de ces entreprises reposent sur une bonne coherence entre l organisation de l unite son environnement socio-economique le niveau d'utilisation du capital et les buts du chef d entreprise Aussi, les entreprises individuelles paraissent-elles plus performantes que les groupements ce qui limite le developpement des activites collectives dans ce domaine

Toutefois l emergence d un secteur de petites et moyennes entreprises plus efficientes exige que des réponses soient apportees aux differents problemes notamment a travers la creation d'un environnement technologique et socio-economique plus favorable

Dans ce cadre les implications au niveau politique concernent la mise en oeuvre de mesures et d actions specifiques visant a une organisation progressive c est-a-dire une reconnaissance officielle de cette filiere Celles ci peuvent être resumees dans les trois volets ci apres

Tableau N°5 Structure et répartition des entreprises collectives dans les departements de production de gari

Bénéfice par unité de produit (FCFA/Kg)				Nombre d entreprises
		BUP	≤ 2	5
2	<	BUP	≤ 4	3
4	<	BUP	≤ 6	4
6	<	BUP	≤ 8	3
8	<	BUP	≤ 10	3
10	<	BUP	≤ 12	2
12	<	BUP	≤ 14	2
14	<	BUP	≤ 16	1
16	<	BUP	≤ 18	1
		BUP	> 18	4

Volet technologique

Les limites a la mecanisation d une ligne complete permettant un travail en continu (ou semi-continu) sont aujourd hui bien connues et les femmes rurales ne seraient pas necessairement les beneficiaires d'une fabrication industrielle Certes il ne s'agit pas de s en tenir aux acquis actuels, mais plutôt de mettre en oeuvre une politique technologique adaptee qui repose sur un processus de diagnostic participatif avec des moments d equilibration et d ajustement systematique Cette politique qui doit s etendre a d autres produits ou filieres se basera sur le triptyque recherche information-formation

La recherche sera consacree a une analyse approfondie des operations technologiques encore traditionnelles et a leur amelioration ou même a leur melange avec d autres techniques (par exemple enrichissement artisanal du gari avec des proteines d origine vegetale) L axe formation permettra de developper les competences de tous les acteurs, les ingenieurs tout comme les transformatrices rurales ou les paysans Pour ce qui concerne l information il s agit de favoriser la circulation des references techniques et temoignages Par exemple, une large information sur les foyers ameliores et puis leur diffusion permettraient de diminuer considerablement les charges liees a l achat du bois de chauffe tout en preservant la sante des productrices contre la fumee

En fait, l objectif serait de promouvoir un reseau ou circule tout ce qui permet d aider a la mise en place et au developpement des entreprises rurales

— dans un secteur de plus en plus formel — a savoir des produits ameliores, des competences reproductibles et des informations

Pour l animation d'un tel reseau, il faut associer les centres de formation professionnelle, les centres de recherche-developpement et les projets

L initiative de creation d une Base d appui technologique prise par les chercheurs du Departement Nutrition et Sciences Agro-alimentaires de la Faculte des Sciences Agronomiques (NSA/FSA) de l Universite Nationale du Benin (UNB) repond bien a cette necessite et merite donc d'être soutenue par les decideurs politiques et les institutions de financement

Volet credit

Une politique de credit approprie est indispensable pour accroître les possibilites des entreprises d acceder au capital afin d'augmenter leur dimension Par ailleurs, compte tenu de l'etroitesse des marges de manoeuvre au niveau local ce volet pourra jouer le rôle d accompagnement pour les diverses actions envisageables

Volet infrastructure

Le desenclavement de certaines localites de forte production permettrait d'ouvrir de nouveaux marches et de dynamiser les echanges Par ailleurs, une politique de realisation d'infrastructures modestes pour le stockage collectif de gari permettrait aux productrices de resister aux tractations des commerçantes et de maintenir le prix du gari a un niveau relativement stable quelles que soient les periodes Ainsi la structure chargee de la gestion de cette infrastructure, de par sa nature (groupement ou cooperative de services) a de fortes chances de succes, contrairement aux structures de production collective Le cadre organisationnel ainsi cree pourra servir egalement a mettre en oeuvre toutes les actions relatives a la promotion de la filiere

Bibliographie

Bricas M et al (1980) L artisanat alimentaire ALTERSIAL GRET ENSIA Massy Paris

Burne Simon (1988) La technologie au service de l agro-alimentaire In Ceres n°124 vol 21 n°4 juillet-août 1988

CIRAD - SAR/ Laboratoire STSC (1993) Conditions d'emergence et de fonctionnement des entreprises agro-alimentaires rurales — Problematique et orientations methodologiques

FAO (1991) Amelioration des procedes traditionnels de transformation de certains oleagineux et du manioc — Resultats des travaux realises aupres de groupements feminins de production et de trans formation Rome

GTZ/ONC (1990) Etude sur la securite alimentaire n°5 Projet SECAL — Production et commercialisation du gari au Benin Cotonou

ILO (1984) Rural small-scale industries and employment in Africa and Asia (Industries rurales a petite echelle et emploi en Afrique et en Asie) Schuta Enyinna et Sthuraman S V Geneve

Malassis Louis (1986) Economie agro-alimentaire III L economie mondiale Ed cocas Paris P 449

Mamah M J B (1991) Programme d appui au secteur industriel BEN/023 — Projet d assistance technique PNUD/ONUDI Benin

Muchnick J et al (1982) Innovation et adaptation de technologies pour l industrialisation des pays africains — les industries agro alimentaires le cas de la transformation du manioc Ministere de la cooperation et du developpement ENSIA

Muchnick J et al (1984) La transformation du manioc technologies autochtones GRET - Altersial ENDA

Olufemi Oludimu (1991) The contribution of rural nonfarm enterprises to rural employment in southwest Nigeria (La contribution des entreprises rurales non fermieres a l emploi rural au Nigeria) In Issues in African rural development Doss Cheryl R et Olson C Winrock International Arlington USA

Ripatti (1989) Les besoins des productrices de gari en milieu rural au Benin — A propos de l observation de trois groupements cooperatifs Cotonou Benin

Treillon, Rolland (1992) Innovation technologique dans les pays du Sud

Wanpko E (1990) Agro industrie et secteur agricole au Benin Th Ing agro FSA/UNB Abomey-Calavi Benin

Irrigation in Botswana Water Conserving Techniques or Optimal Strategies?

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SUMMARY
Rainfed arable production is a major problem in Botswana and other semi-arid countries However, for many reasons, Botswana has a weak irrigation base There are not many perennial rivers to support intensive irrigation schemes Until this study was carried out the knowledge levels of farmers who are involved in irrigation were not known Equally unknown were the perceptions of local farmers about the advantages of using various irrigation techniques Apart from the fact that there is virtually no previous research on irrigation in Botswana, the country has no irrigation policy

This study is a first attempt to examine irrigation activities in Botswana, using the Tuli Block as a case study Its objectives were, first, to identify the different irrigation techniques used by the farmers who are doing irrigation at a commercial level and, second to investigate the reasons for farmers' choices of irrigation technique

The research established that in the Tuli Block, farmers use flood (canal) irrigation, sprinklers, microjets, drip irrigation, and center-pivot irrigation Most local farmers use flood irrigation, while the other techniques are popular with settlers The reason local farmers say they use flood irrigation is that it is cheap to install and maintain and simple to operate However, this technique wastes too much water and may, in the long run, be more costly than its users perceive Settlers prefer microjets and drip irrigation because of the reliability of these techniques

To encourage wider use of techniques that conserve water and the soil, it is recommended that the state subsidize them

Botswana is a dry country Most of its soils are unsuitable for arable agriculture Except in years of drought, pastoral production normally does better than arable farming The nation depends on South Africa for the bulk of its food requirements, including even the cereals that are the staple food of its people Government efforts to increase the productivity of arable production might be enhanced if irrigation expanded greatly But there has been no serious interest in promoting or discussing irrigation technology This neglect may represent a lost opportunity to increase food from locally grown crops, especially because Botswana is currently irrigating only 12% of its potentially irrigable land (Seckler 1992, table 1)

Worldwide, there has been a trend toward irrigation systems that apply low volumes of water at frequent intervals (micro-irrigation) in contrast with systems that apply high volumes at longer intervals (macro-irrigation) Micro-irrigation has been successfully used on some estates and farms in South Africa over the past decade and a half (Pyle 1985, 1) Micro-irrigation refers to the use of sprinklers, microjets, and the drip, while macro-irrigation refers largely to flood irrigation and the center-pivot system The optimal choice of irriga-

tion technique depends on many different but related factors such as soil attributes (e g texture drainage and permeability) amount of water available amount of resources to which the farmer has access (management and capital) water-saving strength of the technique labor savings power savings and yield of the crop under the technique

This study investigates irrigation techniques used by farmers in Botswana Knowledge about the efficiencies of the various irrigation techniques was already available The aim of the research was to establish why farmers choose the techniques they use It was assumed that the techniques used are optimal from the point of view of the users In this context what is optimal embraces the following attributes

- raising returns to factors of production through increased output per unit of water through reduced costs or losses, or through a combination of them
- improving agricultural product quality
- reducing production risks
- facilitating the implementation of wider goals i e convenient

The study aims to bring to the surface the context that makes the use of the techniques optimal A byproduct of the research is to find out how much the farmers know about irrigation techniques and why they do not use those regarded to be the best by the society Broadly therefore the research attempts to establish the overall reasons farmers enter into irrigation The primary question is whether the venture is social economic or both

An earlier study in the Tuli Block(Mazonde 1987) established that ranching has not only an economic motive but a social one as well The social element of ranching manifested itself in the purchase and production by farmers of certain breeds of animals that are associated with high social status Of interest in the present study is whether or not irrigation also has a social motive If it does how does the social motive influence irrigation particularly the choice of irrigation techniques used by the farmers? How does irrigation fit within the overall economic activity of the farmers?

The provision of answers to such questions is a crucial step in the search for an irrigation policy in Botswana An irrigation policy is meaningful only if it is based upon accurate knowledge of the reasons farmers enter into irrigation in the first place However even at this early stage in the formulation of a viable irrigation policy this study makes a concrete recommendation on the kind of support that government should afford farmers who are involved in irrigation

Study Objectives and Design

The objectives of the study are to identify all the irrigation techniques used by the farmers in the Tuli Block for commercial crops and to study the reasons farmers use different techniques

In Botswana irrigation occurs on a commercial scale in three locations Tuli Block farms in eastern Botswana Chobe farm in the north on the banks of the Chobe river, and Mogobane farm in southern Botswana near Gaborone Irrigation is done most extensively in the Tuli Block Outside the three main areas, there is some irrigation but on a very limited scale and usually for subsistence It also tends to be discontinuous due largely to the unreliable water availability Although that irrigation involves many households and might have some potential for expansion it is not covered This study deliberately limits itself to commercial irrigators Nonetheless the findings have some bearing on the improvement of irrigation in general

All Tuli Block farms were visited Of the 152 inhabited farms in the Tuli Block [22] 32 farms reported having practiced some irrigation in the past Nevertheless only 15 were still doing irrigation for commercial purposes and on a continual basis There were 97 other farmers who occasionally water fruit trees around their houses and also keep kitchen gardens from which they produce vegetables for their own consumption Because the scale of their crop production is considered noncommercial, such farmers have been left out of the study All 15 farms involved with commercial irrigation were included in this study

[22] Twenty three farms mainly in the north were not inhabited by people at the time of data collection Their owners are reported to have abandoned them It is not known if the abandonment is temporary or permanent

Food Production In Botswana

The need for water conservation and water-saving technology for irrigation in Botswana is well documented On average 4 out of 7 years are drought years It could be said that drought years are normal, while years that have adequate rainfall for cultivation are exceptional Consequently the majority of Batswana farmers are not able to produce enough to meet their food needs

A survey in 1974 showed that 91% of the households considered that they frequently never produced enough food Actually, for the 1970/71 agricultural year 84% of all households did not produce enough food for their own requirements (Botswana Government 1974 50)

Agricultural production as well as the number of households (and individuals) participating in agriculture, has declined over the years At independence in 1966, the share of agriculture in GDP was 40% It has dropped to 3 5% currently, thus creating greater food deficits than before

Botswana has had to import grain from other African countries mainly South Africa, to make up for the food deficit (table 1) It can be seen from table 1 that grain imports have exceeded the amount of food produced locally for a decade But in the very dry year 1991/92, even South Africa had to import food so Botswana, like other countries in the sub-region, had to depend on food aid from the West

Low rainfall is not the only reason Botswana produces insufficient food Draught power is a major constraint A study carried out in 1992 showed that only 11% of households had access to sufficient draught power for plowing (Molutsi and Mazonde, forthcoming) Another reason is labor shortage, as a result of strong migration from rural to urban areas

Table 1 Botswana's cereal balance (000 t), 1979-90

Year	Production	Imports	Total requirements
1979/80	49	127	176
1980/81	58	96	154
1981/82	19	132	151
1982/83	16	242	258
1983/84	9	242	251
1984/85	20	211	231
1985/86	22	200	222
1986/87	22	169	191
1987/88	107	173	280
1988/89	79	152	231
1989/90	48	146	194
Avg	40	172	213
SD	31	147	48

Calculated from Botswana Government 1991

Labor shortage manifested itself after independence when monetarization of the economy fueled a spirit of individualism and people lost interest in arable agriculture, preferring instead to take up paid jobs in urban areas The combined effect of these two problems has been a declining area under cultivation A major cause of low returns in agriculture is inappropriate technology, which is the subject matter of this study However rather than discuss inappropriate technology, the focus of this research will be on non-optimal technology

Within Botswana s agricultural sector, livestock production is much more rewarding than arable production In drought years, for farmers who own boreholes, livestock farming may be 50 times more profitable (ILO/SATEP 1987) Nevertheless arable production deserves attention and improvement because it involves more households than pastoral production This is because livestock ownership is very skewed Forty-five percent of all households are without cattle, but 5% of the cattle owners have 60% of the total cattle

While the government has always had a program to assist livestock production, it has only recently developed a policy to strongly support arable production The goal of the government is self sufficiency in food production, particularly staples The government has launched several schemes to increase the capacity of farmers to produce crops Two of the major schemes, the Arable Lands Development Program (ALDEP) and the Accelerated Rainfed Arable Program (ARAP), promote the adoption of improved or more efficient technologies in arable agriculture As will be argued in this study, first examining the entire production strategy of the farmer is crucial in order for the technology question to be addressed To a farmer, an optimal strategy may be the basis of his programs, and not necessarily what is seen by others as an appropriate technology

ARAP and ALDEP were targeted to subsistence farmers within the communal areas They have not been made use of by the commercial freehold farmers A few of the latter have used the Financial Assistance Policy (FAP) package, a scheme meant to finance a broad range of economic production ac-

tivities including commercial livestock and crop production

The Tuli Block

Physical features

The Tuli Block, where the study was conducted, is a narrow strip of land stretching 208 kilometers along Botswana s eastern border with South Africa Its average width from the river to the backline fence is 10 kilometers The total area of the block is therefore 2,080 square kilometers, or about 500 000 hectares The Limpopo river forms the block's eastern boundary This river is also the frontier between Botswana and South Africa

Rainfall in the Tuli Block decreases from an average of 378 millimeters in the southern tip to an average of 285 millimeters in the north As in Botswana in general, most of the rainfall occurs between October and March as heavy torrents of a short duration This results in a high level of runoff and low penetration Hailstorms are frequent Rainfall is unreliable with a 90% probability moisture of 205 millimeters in the southern half of the block

The mean monthly maximum temperature varies from 10°C in June to 38°C in December In the north frost can occur between June and early August

As a result of the very high temperatures, the potential yearly evapotranspiration is high 2 500 millimeters Crops are easily scorched by the sun while the moisture in the soil is lost rapidly This underlines the need for irrigation, especially because of the high runoff

Topographically the Tuli Block is dominated by two features the flat plains and the hilly and undulating pediplains sometimes referred to as foot plains Soils are mainly alluvial and were formed as a result of previous channels of smaller rivers that drain the area In the north, the soils are medium textured reddish-brown, sandy loams with some outcrop of heavy clay patches In some cases, soils are deep and have a high sodium content The sandy loams are ideal for most irrigation techniques while the heavy clay patches make most irrigation techniques very difficult By contrast in the south the soils are sandy loam and are shallow with gravel and sandstone at 60 centimeters Some saline/alkaline conditions have been observed near the Limpopo river on a small area of potentially irrigable land

Farming

The Tuli Block was first settled by British exsoldiers at the turn of the century with the primary purpose of curbing the expansion of the Afrikaners from the Transvaal, South Africa The predominant form of land use in the Tuli Block has always been cattle production for beef Cattle raised in the Tuli Block were sold outside the country, mainly to South Africa, on the hoof In 1956, an export abattoir was opened in Botswana, which had a monop oly on exporting beef and live cattle Its opening brought to an end the profitable business of export ing cattle on the hoof by individual farmers Most settlers then took to crop production Some of them also practiced irrigation

Until Botswana s independence in 1966, the Tuli Block was an exclusive freehold area of European settlers After independence, local (Batswana) farmers entered the Tuli Block and farmed alongside the European settlers who had extensive experience in farming and irrigation At Botswana s independence most European settlers were third-generation farmers—their grandfathers had been farmers as well By contrast the locals were first-generation freehold farmers who had no experience in freehold cattle production or irrigation

However, for both the settlers and the locals, cattle production has remained by far the main activity Crop production has been a second priority Farms vary greatly in size among either the settlers or the locals and also between the two groups Among the settlers farms vary from 1,000 to 7,000 hectares, with an average of 2,700 hectares Among the locals farms range from 500 to 4,000 hectares, with an average of 900 hectares Arable crop production occupies less than 10% of the total farm area within either group of farmers On average, settlers who produce crops have 40 hectares of land under irrigation while locals have 10 hectares The situation is not different on farms operated by the Botswana Development Corporation (BDC) On them, crop production occurs on a much larger area simply because the farms are much larger than

individually owned ones For example Seleka farm, owned by BDC measures 18 000 hectares

While most settlers live on the farms and derive their livelihoods mainly from farming, most local farmers live in the villages away from farms The locals derive their livelihood mainly from other economic activities such as trading outside the farms in their villages and urban areas For virtually all of them freehold farming (in the Tuli Block) is neither the main occupation nor the major income-earning activity Freehold farming is therefore a secondary economic activity, even though they keep many cattle, both inside and outside the freehold farms

A major point about the local farmers in the Tuli Block is that their farming shows that most are concerned with building personal image They buy exotic bulls at exorbitant prices and engage in other fancy dealings for which they do not appear to be financially ready However, their farming is characterized by low technological levels In contrast settlers avoid self-aggrandizement in their farming They seem to be purely concerned with profit making In general the technological levels of their farming are higher than those of the locals Specifically, the integration of crop production and livestock raising is more visible on most settler farms and BDC farms than on farms owned by locals The main link is the processing of crop residue for consumption by livestock This process entails grinding corn stalks after harvest and adding salt and other nutrients to produce a mixture that is fed to livestock On farms owned by locals the most common link is cattle manure which is used as virtually the only fertilizer This is because all local farmers, except only one, use solely canal irrigation Use of manure lends itself more readily to the canal irrigation technique and less to other irrigation techniques

Irrigation Techniques

A number of irrigation techniques can be found in the Tuli Block including flood irrigation, sprinkler irrigation, microjets, drip or trickle irrigation, and, the center-pivot system The techniques have varying efficiencies The most efficient ones, such as the drip and the microjets, were developed for well-managed soils and cooler climates of the developed countries Due especially to the scorching effects of the sun in Botswana as well as the clayey soils, which are bad for irrigation, some irrigation techniques are not quite suitable In the Tuli Block, most farmers use more than one technique, depending on the crops they grow, and their economic means

The choice between one technique and another, or the various combinations is based, to some extent, upon the amount of water available, resources, and soil types Another influence on the choice of a technique is social and covert It has to do with how much a farmer is prepared to spend on irrigation, not necessarily how much resources he commands A strong factor in the choice of irrigation technology is that water supply from the main source—the Limpopo river—is free If it were purchased, farmers might use water-conserving technologies

Throughout the Tuli Block, there are two sources of water for irrigation—surface and underground Surface water is from the river (mainly the Limpopo, but in some cases its tributaries such as the Motloutse also provide surface water during rainy months) Underground water is from boreholes that have been drilled on the farms and in the riverbeds of the Limpopo and its tributaries Compared with the western part of Botswana, the water table in the Tuli Block is close to the surface—20 to 30 meters deep By contrast, the water table could be a staggering 200 meters below the surface in the sandveld of western Botswana

During the long current drought, boreholes in the Tuli Block farms have dried up, just like the Limpopo river The unreliability of the water from the river and from boreholes compels farmers to wait for the rains to come before starting to irrigate In other words, if it has not rained at all, farmers find it difficult to irrigate In part, this is due to the dry weather, which tends to dry the soil so much that it must be wetted and softened by rainfall before it can be irrigated

Flood (canal) irrigation

Flood irrigation, also known as canal irrigation, is the oldest and perhaps the simplest form of irrigation In this technique, water is drawn from the river either directly or via a reservoir into a fur-

row that feeds the plant through narrower furrows The narrower furrows feed discs or basins that have been formed under the canopy of the plant which are formed to enable the water to sink to the roots of the plant Drawing water from a reservoir is more efficient because the flow of water can be regulated whereas it is difficult to control the flow of water coming directly from the river

In Tuli Block flood irrigation is used mainly in citrus because the plants require large amounts of water and are strong enough not to be broken by a strong water flow coming directly from pipes However a few farmers use flood irrigation on vegetables which is an indication of poor irrigation management

The advantages of flood irrigation are that it is simple inexpensive and very flexible It is also the cheapest to run because it has low capital inputs and is cheap to maintain and it can be applied in almost every soil type

The disadvantages are many It is also the most wasteful of all irrigation techniques Large amounts of water are lost in the furrows through seepage Ideally flood irrigation should be used only where there are substantial water reserves as on the Chobe farm where water is continuously abundant In the Tuli Block flood irrigation is suitable when the Limpopo river is flowing and has a lot of water Such years have been rare in the last decade The technique also disturbs the soil structure as water flows through the furrows and when it enters the basins under the canopy of the plant Eventually, soil erosion results particularly where water is drawn directly from the river through a powerful engine so that it flows with great force This technique usually exposes the plant roots because of the direct impact of the flow of water from the furrow into the basin

Because water used through this technique is usually not filtered for weed seeds and is not treated against water-borne diseases weeds always grow inside the tree discs and plants so watered need frequent treatment against diseases

In the Tuli Block the technique is labor-intensive due to the easy silting of the furrows, which need constant drenching and the weeding of plant-watering discs To use flood irrigation the terrain has to be made to incline toward the source of the water so that water in the furrows moves fast and with minimal inertia to the plants Such inclination contributes to overtop or soil erosion which in turn causes silting of furrows Eventually maintenance of furrows becomes costly because they have to be drenched often This problem influences the scale on which flood irrigation can be practiced

Yet another disadvantage of flood irrigation is that the quality of water for irrigation (physically and biologically) and the manner in which it is applied to the plant can be unfavorable for production of crops from tender plants like tomatoes and onions Generally flood irrigation is not suitable for vegetable crops

It is estimated that flood irrigation is only 40% efficient Efficiency refers to the amount of water used by the plant as a proportion of amount of water applied to the plant This is because in the process of its movement and use water is lost in many ways including a high evapotranspiration rate A plant requires water constantly and in amounts that it can use In Botswana farmers who use flood irrigation usually apply large quantities of water in one day Once again this shows their poor irrigation management techniques Most of the water is wasted because it does not percolate to the root but largely wets the unproductive areas Where soils are hard, waterlogging may result In this situation water is trapped in one place and does not pass downwards to the roots of the plants

Efficiency does not take the yield of the irrigated plant into consideration This is because there have been few well-proven claims of direct yield increases due to any particular irrigation technique (Pyle 1985, 4) The paramount concern in the efficiency of an irrigation technique seems to lie mainly with water saving

Sprinklers

Sprinklers may be regarded as the next stage of technological advancement after flood irrigation In this technique water is drawn from a reservoir through pipes and into a sprinkler a mechanical device that sprinkles water directly onto the plant One advantage is that it does not require level terrain because water does not flow over the ground on its way from the source to the plant as with flood irrigation The water wasted through seepage along the way from the source is therefore minimal

Second, there is no possibility for waterlogging Third, and a very strong advantage in Botswana, is that as the water falls upon the plant canopy, it cools the plant, thus saving it from the temperatures that can be very high Fourth, when a sprinkler is used, other agronomic procedures, such as the application of fertilizers (in the water) and some amount of water purification (and disease control) are possible BDC does that throughout its farms, but no individual farmers do

Nevertheless, there are problems associated with sprinkler irrigation It cannot be used in crops such as sugarcane and sunflower because lateral pipes cannot be moved between the plants (However in Botswana those crops are not grown, the technique is used on maize and vegetables) Another drawback is that the sprayed water may increase the transmission of wind-borne diseases from one plant to another, a situation experienced by tomato growers in the Tuli Block

Microjets

Microjets were developed specifically to conserve water used in irrigation Technologically, they are more advanced and more efficient in conserving water than sprinklers Although they vary in design, basically they are mist sprayers that are placed inside the basin around a plant where they apply an aerated spray of water directly but at low intensity to the root zone of the crop Releasing water in the form of mist reduces the erosion of the topsoil inside the basin

A microjet contains a filter that maintains the cleanliness of the water There is an S-type rotation jet and a D-type The D-jet emits mist water at a low angle, resulting in low evaporation and a reduced chance for the transmission of wind-borne diseases Like sprinklers, microjets allow inputs such as fertilizers to be applied to the soil simultaneously with plant watering In Botswana, microjets are used mainly in growing lucerne and in horticultural crops

Drip irrigation

Drip irrigation is considered the most advanced and most efficient form of irrigation Water is slowly applied into the soil through mechanical devices called emitters The water is emitted straight into the root zone of the plant Whereas a microjet can yield 70 liters of water per hour, a dripper yields just 2 liters per hour The technique does not allow any loss of water through evaporation A more important mark of its superiority over other irrigation techniques is the fact that it emits water only into the productive part of the soil This makes its conservation component the most efficient of all Another advantage is that because of the slow release of water, it requires only small (and therefore cheaper) engines to pump the water from a reservoir In the Tuli Block, drip irrigation has proved to be adaptable to the heterogeneous soils that are capable of maintaining low-tension moisture around the root zone of the crop

A common problem of other irrigation techniques used during harvest is overwetting of the basin around the tree Where a dripper is used, the basin and the rest of the area around the fruit tree remain dry so that harvesting and watering can be done simultaneously without one activity disturbing the other That is important because it also prevents the development of oleocellis, a fruit disease that usually occurs when an orchard is irrigated too close to harvest or when a fruit tree has received insufficient water prior to harvest In the Tuli Block, BDC uses drip irrigation in the production of vegetables So far, individual farmers do not use it

Center pivot

Center-pivot irrigation is employed mainly in large-scale arable production The technique comprises a radial arm that rotates around the center pivot in a field, distributing water from the top The system is operated by a diesel or electric motor The amount of water released to the crop depends in part upon the speed of the system, which is controlled by a percentage timer a mechanical component inside the tower box The faster the speed of the system, the smaller the amount of water let out

An advantage of the center pivot is that it is capable of operating itself Consequently, it is possible to water a large field 24 hours a day, without using labor To take full advantage of the technique, farmers who use it water their crops at night when evapotranspiration is lowest Watering at

night also helps protect the leaves of plants from frost damage in winter Another advantage of the center pivot is that its self motion pre-empts the need for laborers to move water pipes from place to place in the techniques discussed earlier

However, like canal irrigation this technique requires large amounts of water It is not very efficient though somewhat better than canal irrigation The technique has the highest initial cost of all techniques It requires more sophisticated skills to service it than other irrigation techniques When it is used during the day a lot of water can be lost through evaporation especially in the summer of Botswana where temperatures can reach 38°C For the system to operate efficiently and to prevent waterlogging the soil has to be leveled Without such preparation the wheels of the center pivot may get stuck during its movements especially when it is unattended

The center pivot is the most expensive technique followed by the drip then the microjet after which comes the sprinkler Flood irrigation is the least expensive of all these techniques

Data Collection and Analysis

Both qualitative and quantitative data were collected jointly by the researcher and an assistant at bi-monthly intervals from February to December 1992 Qualitative data was mostly a result of direct observation by the researcher The qualitative data included the history of irrigation for each of the farms currently practicing irrigation on a commercial basis For the Tuli Block historical data collection included materials from those resident farmers who have at one stage carried out irrigation A preliminary survey had established that there was considerable variation in the pattern of irrigation among farms in the Tuli Block

To collect quantitative data, no questionnaire was used Instead questions were asked in each of the 15 Tuli Block farms about

- types of farming practiced (wildlife livestock arable)
- farmer s perceptions about modern and traditional farming
- types and varieties of crops grown
- scale of farming by crop
- amounts of crop harvested at end of farming year
- amount of annual income from each crop
- whether crops are grown seasonally or continually
- irrigation techniques, i e flood sprinkler, microjets etc
- use of pesticides and weeding methods
- type of labor deployed and its skill levels
- farming implements used
- disposal of crops (where and to whom are they sold)
- any conservation of ecosystem by farmer
- links between arable and livestock production

Due to the small number of farmers in the study, no elaborate statistical techniques are used Nevertheless, the data provides a clear picture of the nature of the irrigation activity in the Tuli Block Qualitative data complement the analysis of quantitative data Unless otherwise indicated, the source of all tables is the field work

Research Results

A farmer normally chooses an irrigation technique on the basis of his crop production intentions An important component of irrigation technology, therefore, is the kind of crop grown, and whether it is grown throughout the year or seasonally Table 2 shows the crops grown under irrigation, the numbers of farmers growing them, and the growing period Considering that the Tuli Block has a surface area of 500,000 hectares, the 4,160 hectares under commercial irrigation are a very small portion

Although it would have been useful to calculate the amount of water used by each crop, such information could not be obtained because when water is drawn from a reservoir it irrigates many crops However, it was possible to extract the weekly volumes of water used by each farmer by technique The reason is that even though some farmers have installed different techniques, and even though pipe connections enable the farmers to use water from any reservoir, the water pressure that is required for operating one technique does not allow the use of any other irrigation technique

Table 2 Tuli Block Crops grown under irrigation, 1991

Crop	Farmers (no)	Growing duration	Area under irrigation (ha)
Maize	12	seasonal	900
Beans	9	seasonal	550
Citrus fruits	15	throughout year	1 200
Sunflower	4	seasonal	150
Vegetables	10	throughout year	680
Lucerne	5	throughout year	230
Cotton	4	seasonal	450
Total			4 160

at the same time Only weekly amounts could be calculated because crops such as maize and beans are not watered daily Also, some crops, oranges, for instance, are watered seasonally (i e , only during summer and in spring) on some individually owned farms, while on others, they are watered every 2 months

Use and efficiency of various irrigation techniques

Farmers in Tuli Block use various irrigation techniques (table 3), and some farmers use more than one In a location like the Tuli Block where water is such a scarce commodity, water conservation should be a prime consideration when evaluating the idealness of an irrigation technique The efficiency of each technique is rated by irrigation engineers when it is designed (Pyle 1985) By implication, the inefficiency of the technique is inbuilt For instance, canal (flood) irrigation is rated to be only 40% efficient That means 60% of the water that is applied to a crop through flood irrigation is lost

Knowing the efficiency rating of a technique and the amount of water used through it makes it possible to compute the amount of water lost Table 4 gives the efficiency rating of each technique and estimates of amounts of water used in irrigation in the Tuli Block as well as the amounts of water lost through inefficiencies of the techniques Drip irrigation uses the largest volume of water because it is used mainly on vegetables, which are watered daily and continuously The efficiency of the different techniques is reckoned in water used and lost Further, the efficiency in the application of the techniques would normally vary from one farmer to another depending on the farmer's experience and

Table 3 Tuli Block Use of various irrigation techniques

Technique	Farmers using technique	
	no	%
Flood irrigation	10	67
Sprinklers	8	53
Center pivot	4	27
Microjets	7	47
Drip	4	27

skill (Makhado 1987) In table 4, water used refers to the amount released from the reservoir and then applied through each technique not the amount actually used by the plants The amount of water used by the plants would require calculations beyond the scope of this research

Based on the efficiency ratings of the techniques used, 94,350 of the 229,000 cubic meters of water released for irrigation in the Tuli Block, or 41%, are lost every week However, this is merely an apparent loss Some of the water lost through the inefficiencies of irrigation techniques performs the very important work of cooling the plants This is the case where sprinklers are used Excluding water lost through their use losses from other techniques total 73 350 cubic meters a week Clearly, the loss of irrigation water is considerable in the Tuli Block

The competition for water by the different activities in the Tuli Block (table 5) underscores the need for water-conserving irrigation techniques The figure for livestock is based upon livestock census data and the fact that on average, cattle drink 20 liters of water per animal per day in winter and 40 liters per day in summer Goats drink 5 liters per day in winter and 8 liters day in summer It is not possible to estimate the amount of water consumed by wildlife because of absence of wildlife statistics and drinking behaviors One very important statistic that could not be obtained is the amount of water in the Limpopo river at any given time Nevertheless, the facts that the river has not

Table 4 Irrigation efficiencies and estimated amount of water lost in the Tuli Block

Technique	Efficiency (%)	Amount of water (000 m^3/wk)	
		Used	Lost
Flood irrigation	40	54	32 4
Sprinklers	50	42	21 0
Center pivot	50	40	20 0
Microjets	65	35	12 2
Drip	85	58	8 7
Total		229	94 4

Table 5 Activities that compete for water in the Tuli Block

Activity	Water use (000 m^3/week)
Crop production	229
Livestock	1 050
Wildlife	
People	50
Manufacturing	50

been in flood for 4 years that some of its pools are so low that they prohibit irrigation works, and that some boreholes have run dry are clear indicators that the water resources of the entire Limpopo valley are under great strain

Reasons irrigators use particular irrigation techniques

For a primary stage investigation such as this one it is vital to know the reasons for farmers choices of irrigation techniques Table 6 shows the responses when farmers were asked why they used each irrigation technique A strong factor is the costs of buying installing operating and maintaining the system The farmer has to consider the likely levels of the financial returns he can make from the system The terrain and the type of crops he wants to grow are also important The analytical frame that best takes these factors into account is created by comparing the last two tables with table 7 which shows the cost of buying and installing the various irrigation techniques found in the Tuli Block and the estimated costs of operating each technique The cost of installing flood irrigation is much higher than the indicated US$150/ha, but low cost labor makes it cheap to dig trenches (canals) Operating costs should normally be lower than the cost of installation The reality, however is that even though the cost of labor is initially low, it is increasing all the time

The operating costs in table 7 are estimated averages based on the number of people employed and the wages paid them by farmers and for each irrigation technique Flood irrigation, the technique with the lowest efficiency rating also has the lowest operating expenses because it is very simple and the least skilled labor can be employed to run it Drip irrigation the technique with the highest efficiency rating is not the most expensive in terms of installation and operating costs It must be admitted however, that its installation cost is high and may be out of reach for many farmers

Table 6 Reasons given by irrigators for using particular irrigation techniques

Technique	Farmers (no)	Crops grown	Reasons for using technique[a]
Flood irrigation	10	Maize citrus beans vegetables	Cheap (6) Simple (4)
Sprinklers	8	Maize beans vegetables lucerne	Conserves water (4) Effective (4)
Microjets	7	Citrus vegetables sunflower	Saves water (4) Effective (3)
Drip	3	Sunflower vegetables	Resourceful (3)
Center pivot	1	Vegetables cotton maize	Saves time and labor (1)

[a] Number of farmer giving response shown in parentheses

The likely reason most farmers (67%) opt for flood irrigation is that they consider it cheap (table 6) Table 7 confirms that the flood irrigation is cheaper than other technique It is crucial, however, to explain what that means First, the farmers are looking at the costs of buying and installing the technique In comparison with other techniques, flood irrigation requires less capital inputs Most cash input goes into the digging of canals, which can be achieved with cheap labor Clearing the canals of silt is done at no extra cost as part of the watering procedure Other techniques, by contrast, require relatively heavy initial cash inputs to buy the equipment (sprinklers, microjets, center pivot etc) Over time, these machines depreciate and need to be replaced The replacement cost may be too high, especially considering that prices of agricultural goods tend to decline relative to the prices of imported manufactured goods such as sprinklers and center pivot systems Flood irrigation seems to avoid depreciation because it is a labor-based technique and the wages of agricultural workers in Botswana, including freehold farm laborers, have been stagnant for quite some time (Gyekhe and Mazonde 1989)

The cheapness and the simplicity of canal irrigation coincide with the wider strategies of the local farmers Their primary interest is cattle ranching Irrigation is to them a sideline Furthermore, the manner in which they conduct cattle ranching on these Tuli Block farms is no different from the way they raise cattle in the cattle posts, away from the freehold farms in the commonage Their animal husbandry in both instances is characterized by low

capital inputs and very low wages for the herders It would appear that the widespread use of the cheapest macro-irrigation technique, canal irrigation, is consistent with this frame of mind

The water is free The only direct cost is the value of the fuel used to run the engine that draws water from the river into the reservoir and from the reservoir into the basins of the plants However, in the long run, the cost of operating this technique can be quite high In addition, in real terms, the high volume of water lost through the use of canal irrigation calls into question the perceived cheapness of the technique But farmers seem to be more concerned with the immediate costs If there were water charges related to the amount drawn, local farmers might perceive the costs of operating canal irrigation differently

This point is tied to the farmers view that drip irrigation technique is 'resourceful" (table 6) When asked what they meant, the common explanation was that the technique conserves water and saves both fuel energy and operating costs Although the technique is expensive to purchase, they found that by comparison with other techniques, it took fewer laborers to operate on any given land area The farmers perceived the depreciation of the technique to be low, given that they do not have to move implements across the irrigated area, causing wear and tear, as is the case, for instance, with sprinklers and microjets

The next logical question then may be, how does irrigation fit within the overall ambition of farmers? In other words, how is the social goal of the farmer (i e , his desire to be associated with a certain class of farmers) satisfied through his use of canal irrigation? The answer is to be found in the nature of the farmers that mainly use canal irrigation Most of them are the locals Elsewhere, I have shown that local farmers in the Tuli Block are first generation ranchers, whereas their settlers are mostly third generation ranchers (Mazonde 1987) What this means is that while the settlers are at the stage of improving their farming with better technologies the local farmers are still grappling with the basics of farming Local farmers seem to derive prestige from being referred to as irrigators in spite of the technological level of irrigation On the other hand the settlers, who mostly live off farming are more concerned with a farming technology that is both profitable and reliable This is not to suggest that local farmers always embark upon prestigious projects at the expense of profit In a number of cases, they make strenuous efforts to strike a balance between the two

While micro-irrigation cannot be said to be more productive in terms of the yield of the crop, it is indisputable that it uses less water As such it is more reliable in that, with a given quantity of water, it can achieve more than canal irrigation What this means is that micro-irrigation can still be used even where macro-irrigation would be impossible owing to insufficient water levels

But of course there are other non-social factors that contribute to the popularity of canal irrigation and also reinforce it Chief among these are the low cost of water and lack of state subsidies in irrigation Although the government has given subsidies for arable farming through ALDEP and ARAP, it has not so far directly subsidized irrigation or encouraged that activity Given the enormity of water shortage in Botswana, this appears to have been a serious lack Subsidies for irrigation might provide an incentive for arable farmers to move away from macro- toward micro-irrigation

According to table 8, a local farmer who produces all four crops listed will earn P50,850 A

Table 7 Costs of buying, installing, and operating irrigation techniques per hectare (1990 prices)

Technique	Farmers using (%)	Efficiency rating (%)	Installation cost (US$/ha)	Monthly operating expenses (US$/ha)
Flood irrigation	67	40	150	150
Sprinklers	53	50	475	250
Center pivot	27	50	975	250
Microjets	47	65	545	275
Drip	27	85	775	200

Source Pyle 1985 field data)

Table 8 Farmers average annual output and value of crops, 1990-92

	Avg output per farm				Value (P)			
Farmer	Oranges (pockets)	Tomatoes (crates)	Cabbage (bags)	Maize (tons)	Oranges	Tomatoes	Cabbage	Maize
Local	1 150	1 410	1 260	1 190	11 500	13 280	12 080	13 990
Settler	2 920	21 200	21 100	21 840	29 200	29 600	28 880	238 640
BDC[a]	33 000	35 500	36 900	34 000	330 000	344 000	355 200	384 000

[a] Botswana Development Corporation

settler farmer producing all four crops will realize an average of P326 320 The largest total turnover from the BDC is P1 416 200 The amounts of money shown do not represent the farmers profits All farmers complain that they either break even or incur a loss The data confirm that irrigation is a sideline activity for local farmers One reason for that is that the overwhelming majority of them are still struggling to pay back the loans they received mainly from the National Development Bank to purchase the farms

With respect to revenue from irrigation it is significant that local farmers do not produce crops throughout the year but many settler farmers do so This fact accounts for the great difference in the amounts of money received by each type of farmer annually from irrigation

Conclusion

This study set two objectives The first was to identify the irrigation techniques that farmers in the Tuli Block use The second was to determine the reasons for the use of those irrigation techniques The first objective was achieved quite adequately and without much difficulty It came to light that all the known irrigation techniques are in use in the Tuli Block The most widely used is canal irrigation which is technically the simplest and easiest to operate It is also the cheapest to install per hectare A disadvantage of canal irrigation is that it wastes too much water The technique is only 40% efficient Next there are the sprinkler the microjets the drip and the center pivot The drip irrigation technique is the most efficient in terms of water conservation This is because it releases only a small amount of water directly to the root zone at intervals and in amounts that can be adjusted In micro-irrigation the drip is the most expensive technique It is also the least widely used irrigation technique The last technique is the center pivot It does not fall under micro-irrigation techniques Rather it is a macro-irrigation technique The center pivot is very expensive Throughout the Tuli Block only the BDC farms and three other farmers use it

The various irrigation techniques were all designed outside Botswana and for environments that may be different from those found in Botswana What has emerged from the study is that farmers seem to take into consideration their entire farming strategies when they choose the irrigation techniques The locals are economically rational in their choice of the flood irrigation technique, a method that wastes too much water The use of this technique is in line with their desire to reduce costs of the irrigation venture Because water is free, except for the cost of drawing it from its source a water-saving technology is not attractive to them, when it is more expensive to install and when it requires higher labor skills to use Nevertheless, the rationality of the local farmers remains a subjective one in that it is appreciated when seen from their own point of view It is the case that in spite its rationality it remains a water-wasting option

On the other hand, settlers find micro-irrigation more attractive because it is more reliable, given the unpredictable amounts of water in the river and boreholes at any given time Reliability is a strong consideration for the settlers because unlike the locals they live off farming Consequently, the farming strategies must be made to be as reliable as possible In other words, at the center of the choice is the long-term and the wider economic interests of the farmer What this means is that the farmer is pursuing an optimal strategy through his choice of whatever irrigation technique he uses This finding lends support to the mainstream view which is well articulated by Ruigu and Rukuni (1990, 138), among others that irrigation requires a human approach because it is concerned with people and not just with land

With such information, it is now possible to develop a scenario of the implications for a policy that promotes irrigation An ideal irrigation policy must be to use implements or techniques that best conserve land and water, the natural resources upon which irrigation depends The conservation of these resources might not appear immediately to be in the interests of the farmers Nevertheless, in the long term, it will be Whatever policy is recommended should reflect such a position

The preference of canal irrigation over other techniques of irrigation in the Tuli Block means that much water is wasted that might have been saved if macro-irrigation techniques such as sprinklers were used Aside from the efficiency of a technique to save water, a premium must be placed on its ability to protect the crop from the scourging heat of the sun Plant protection through irrigation would work to the advantage of any irrigator, including the settlers and the locals, provided their aim was to optimize irrigation as against optimizing their entire economic strategies Canal irrigation is also environmentally destructive in that it washes away good soil and nutrients

Policies should encourage the kind of irrigation that is land and water resourceful, and not one that is optimal in the subjective sense of the irrigator, especially if public funds subsidize irrigation, as I recommend

Recommendation

One policy recommendation is made Government should subsidize micro-irrigation Subsidies should be made only in parts of Botswana that have a water resource base to support irrigation Canal irrigation should not be subsidized at all because it wastes water and destroys the soil A likely result of such a policy is that it would encourage micro-irrigation and discourage macro-irrigation, particularly flood irrigation

A technical study must be commissioned to suggest the levels of subsidy for the different techniques of micro-irrigation A recommendation of the levels of subsidies, following the results of the study that is being proposed, must take into account the balance between water saving and the cooling effect of water on the plant by a particular irrigation technique

One requirement of a good policy is that it be consistent with long-term national goals Raising the level of food production is a top long-term priority in Botswana

Literature Cited

Botswana Government 1974 *Rural income distribution survey* Gaborone Ministry of Finance and Development Planning

Botswana Government 1991 *National Development Plan 7* Gaborone Government Printer

Gyekye, A , and I N Mazonde 1989 A study of minimum wage possibilities in the agricultural and domestic service sectors of the Botswana economy In *Agricultural workers report* vol 2 Gaborone National Institute of Development Research and Documentation University of Botswana

ILO/SATEP 1987 *Report on the labor situation in some southern African countries* Geneva

Makhado, J M 1987 Sprinkler irrigation systems Lecture notes University of Swaziland Luyengo

Mazonde I N 1987 Ranching and economic enterprise in eastern Botswana Ph D thesis University of Manchester

Molutsi, P P and I N Mazonde Forthcoming *Social aspects of Botswana s human development initiative* Gaborone UNDP/UNICEF

Pyle K R 1985 An appraisal of micro-irrigation for use on citrus with an emphasis on drip irrigation *The Citrus And Subtropical Fruit Journal* February p 4-7

Ruigu, G M and M Rukuni eds 1990 Irrigation policy in Kenya and Zimbabwe In *Proceedings of the Second Intermediate Seminar on Irrigation Farming in Kenya and Zimbabwe held at Juliasdale Harare 26 30 May 1987* Narobi Institute for Development Studies University of Nairobi

Seckler, David 1992 Private sector irrigation in Africa Center for Economic Policies Studies Discussion Paper 11 Arlington Virginia Winrock International

Labor Utilization in Peasant Agriculture Private and Cooperative Farms in an Ethiopian Village

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SUMMARY

Much of the development work done in Ethiopia has assumed that Ethiopia has a labor surplus, however, no evidence has been presented This paper examines the concept of labor surplus within the context of an Ethiopian village In Oudie village, 195 households were surveyed to generate data on the available labor force Of these households, 125 were from private farms and 74 were from the collective farm The general survey was followed by an intensive time-allocation survey of 12 households for a week during both the peak and slack seasons

Surplus labor has been defined by some researchers as the labor available for crop production minus the labor required for crop production However, this study argues that surplus labor should instead be defined as the labor available for all necessary activities minus the labor required for these activities In addition to crop production household-maintenance activities and social engagements are necessary to ensure the effective functioning of the household and the community

Three versions of a model were developed to determine the level of surplus labor In two of the versions, the labor available for crop farming was narrowly defined by excluding a substantial portion of women's and children's labor and labor specifically apportioned for animal care Four types of labor were distinguished household labor hired labor community labor, and collective labor

The statistical results suggest the existence of varying degrees of residual labor with respect to labor required for crop farming, depending on the assumptions underlying the model used The proportion of residual labor ranged from 78% of the available labor for private farms (without adjusting for women and children s other activities) to only 55% for the cooperative farms when adjustments were made to exclude the labor apportioned for animal care

However, the time-allocation study indicated that individuals are using most of their time for necessary activities Time devoted to nonwork activities did not significantly increase during the slack agricultural season Instead, other household maintenance activities, such as animal care, gathering fuel, fetching water, and making fences, filled the time that was not being used for crop production

The time-allocation study also revealed patterns of the gender division of labor Women participated in household-maintenance activities to a much greater extent than men, whereas men spent a greater proportion of their time in crop production

The problem of allocating household labor optimally is a crucial economic issue in peasant agriculture If output can be increased strictly by reallocating labor, then purchases of modern farm inputs could be reduced, saving scarce foreign exchange Although some international agencies interested in Ethiopian agriculture have assumed that Ethiopia has a labor surplus little evidence has been presented The existing understanding of labor force underutilization is inadequate

The purpose of this study was to investigate the existence and magnitude of labor force underutilization at the village level and to explore possibilities for developing alternative methodologies for analyzing labor use Labor underutilization should be considered in the context of overall patterns of labor use and the gender division of labor existing in a rural setting

Literature Review

The literature concerning labor-use patterns in Ethiopian agriculture is not only fragmentary but also is virtually devoid of economic analysis Some of the literature was written by anthropologists and some by researchers working in the integrated rural development project areas of Arsi region

Existing rural labor-force statistics such as those of the Central Statistical Office (1985) have a built-in tendency to underestimate the contributions of women and children to agricultural production and to the well-being of the household These statistics were derived from surveys that were based upon concepts designed to measure industrial employment only directly productive activities were included, housework and similar activities were left out As a result the contributions of women and children have been undercounted and undervalued

Problems of undervaluing women s contributions arise from conceptual problems related to leisure In peasant societies the boundary between work and leisure is often blurred, not only due to the existence of overlapping activities such as playing and child care but also because of a lack of an appropriate definition of leisure itself The dictionary definition of leisure is time free from employment during which a person may indulge in rest, recreation etc (Webster's Dictionary) In conventional economics textbooks, leisure is mentioned only in the context of the trade-off between work and leisure Leisure signifies not only idle time but time for recreation—enjoyment of one's time Using this definition only a few activities—such as rest or conversation—fall within the purview of leisure in peasant societies

Rural labor underutilization is among the subjects widely discussed by economists The International Labour Organization has noted, There can be few subjects in the field of economic development which have been the subject of as much theorizing as the concept and measurement of labor-force underutilization in less developed countries' (International Labour Organization 1971)

Three versions of disguised unemployment can be distinguished (Wellisz 1968) The first is a situation of cyclical transfer of persons from more productive to less productive jobs as a result of deficiencies in effective demand (Robinson 1936) This Keynesian' version of disguised unemployment has little relevance to traditional agricultural societies In the second version, a number of people are working on farms or small peasant plots, contributing nothing to output but living on a share of their family s net income In technical terms, the marginal productivity of labor over a wide range is zero (Nurkse 1955 35) This version of disguised unemployment was first developed by Rosenstein-Rodan (1943) and is known as the structuralist version It was with reference to this version of underutilization that Sen noted Much blood has been shed on crusades about disguised unemployment viewed from the production point of view" (Sen 1975 32) Controversy surrounds the structuralist view of disguised unemployment regarding the effect of withdrawing redundant workers from agriculture to the modern sector where the wage-rate is higher than the subsistence wage (e g , Lewis 1954) According to the third version, disguised unemployment is a situation where the average product per person falls below the physical level of subsistence (Nurkse 1957) This version is known as the Malthusian version of labor underutilization

In peasant agriculture, disguised unemployment involves work sharing or work-stretching practices where the preference will be for a leisurely pace of

work rather than for completely idle time' since under disguised unemployment people may all be occupied and no one considers himself idle" (Ghosh 1977, 25-27, 52)

Much of the existing literature focuses on measuring surplus labor by measuring labor productivity or labor utilization A neoclassical production function is used to estimate surplus labor in the labor-productivity approach However, this approach suffers from serious shortcomings, including the lack of reliable statistics, the indeterminance of certain solutions, and the use of unrealistic assumptions (Ghosh 1977, 62-64), which makes it of limited value to measuring conditions of peasant agriculture

On the other hand, the labor-utilization approach considers surplus labor as the difference between the available household labor and the labor required for agricultural operations Some researchers have suggested that this approach is more useful than measuring marginal productivity (Pepelasis and Yotopoulos 1962 Mathur 1964, Yotopoulos 1967) However this method is inadequate for measuring the degree of labor underutilization in peasant agriculture because it does not include labor required for housework and social engagements

The results from empirical studies on the magnitude of surplus labor (e g , Schultz 1964, Mehra 1966, Sen 1975 Lal 1976) varied widely depending on the definitions and assumptions made regarding disguised unemployment Thus, it is easy to agree with Kao and Eicher s (1964) conclusion

The existence of disguised unemployment is largely a matter of definition and the assumption about the institutional forces involved" Little consensus has been reached to challenge their conclusion

Data Collection Techniques

The village of Oudie is 60 kilometers east of Addis Ababa along the busiest highway in Ethiopia In 1987, Oudie village had a population of 1,106 and a land area of 680 hectares Of the 490 hectares of cropland, 49% belonged to the Oudie Agricultural Producers Cooperative—the collective farm Membership in an Ethiopian Peasant Association is open to all heads of households who have land to cultivate crops Only 38% of the total number of households registered as Peasant Association members were members of the Oudie Agricultural Producers' Cooperative This village is representative of much of the surrounding area, which is well known for the production of teff a subsistence and cash crop

In the absence of a single effective technique to collect rural labor-use data, different but complementary approaches were employed These approaches also allowed the data to be cross-checked for consistency

The field work was initiated in cooperation with the local development agent of the Ministry of Agriculture who provided background information Group interviews and documentary evidence generated more detailed background information A household survey used structured questionnaires to generate data on the available labor force The survey covered the whole Peasant Association, which consisted of 195 households One hundred twenty-one of the households were from private farms and 74 were from the collective farm

The household survey was followed by an intensive time-allocation study of 12 selected households All members of the households who were at least 7 years old were included in the study for a total of 50 individuals For the time-allocation study, data was collected for 7 consecutive days during both the peak season and the slack season All activities from the time the individuals woke up until they went to bed were carefully recorded

Method of Analysis

Surplus labor should be defined as labor available for all necessary activities (farm work housework, social engagements) less labor required for these activities What the labor-utilization approach defines as surplus labor—labor available for crop production less labor required for crop production—is actually residual labor It is difficult to estimate surplus labor directly because there is no standard amount of time required for activities such as caring for children, cooking, visiting, and attending funerals This study demonstrates the limitations of the conventional method and suggests possible methods for further research

The labor utilization approach was modified to estimate residual labor using the equation $D_t = A_t - R_t$ where D is residual labor (man-days) A is available labor force for crop farming R is labor required for crop farming and t is one agricultural year

Residual labor exists if $D_t > 0$ and the proportion of the residual in the available household labor is given by D_t / A_t The residual labor per household is given by D_t / H_t where H_t is the number of households This study found $H_t = 195$ for the whole village 121 for the private sector and 74 for the cooperative farm

The available labor was limited to the household labor potential which was composed of the labor of four demographic groups adult males adult females children (7- to 15-years old) and elderly people (over 60 years old) Ideally the labor available for crop farming would be calculated as the sum of household labor potential and hired labor less off farm employment labor lost due to inclement weather or illness and students labor while attending classes or studying However off farm employment was insignificant at the time of the study Data on days not worked due to inclement weather or illness was unavailable Students were not included in household labor potential although they might participate in crop production during nonschool hours

Household labor requirements for self-employment in crop farming were estimated by using crop specific labor land coefficients obtained from farm management studies The labor land coefficient for the study area was obtained by taking the average of coefficients for the nearby Mojo area and Debre Zeit area (where Oudie is found) generated by farm management surveys conducted by the International Livestock Center for Africa and by Institute of Agricultural Research (IAR) The coefficient for barley and sorghum was estimated for the Shoa region as a whole by an expert at IAR It was assumed that the same production techniques were used by private and cooperative farms However some use of tractors was reported on the cooperative farm

Three versions of the model were developed by manipulating the conversion factor to arrive at homogeneous labor in man-day equivalents Many studies have converted women and children s labor into man-day equivalents using a factor of 0 5 This conversion rate is based on assumptions about the productivity of men women and children and on the basis of comparative wage rates (Brown 1979 52-54) However Brown (1979 53) says Experience throughout the world has shown it is a fallacy to assume that a woman s effective output is always less than a man s Thus, in the first version of the model a conversion factor of 0 5 was applied only to children and elderly people Children s main task is to care for animals including plow oxen In the second version of the model women s labor was deflated by their respective time contributions to crop farming Contributions to farm work were calculated in average daily hours spent in agricultural work during the peak season This adjustment takes into account the fact that women's participation in crop farming is constrained by time required for housework Women and children, on average work in the field for fewer hours than men As in the first model a conversion factor of 0 5 was applied to children and to elderly people In the final version of the model the labor of shepherds was deducted from the available labor force to determine the labor available for crop farming Thus, in the second and third versions of the model, the labor available for crop farming is narrowly defined by excluding a substantial portion of women s and children s labor and labor specifically apportioned for animal care

In addition, the residual labor for the cooperative farm was estimated by taking the difference between the expected labor and the labor time utilized The expected labor was calculated by multiplying the number of working members of the collective farm by the net working days (258 days) The labor-time utilized was calculated as the total work-points (measured in hours) accumulated by members as indicated in the records of the cooperative farm, divided by 8 to convert hours into man-days Work points were recorded for tasks such as administration and feeding oxen as well as for crop production In this final version of the model, the labor of women and children was not deflated Women and men earned equal work points for equal work

In the time-allocation study work activities were divided into two broad categories directly productive activities—crop farming caring for animals and making handicrafts—and household mainte

nance activities—caring for children, preparing food collecting fuel and water, going to the mill, making fences, and so on Other activities—taking care of personal hygiene, visiting, mourning and attending funerals, conversing, eating meals, drinking coffee resting praying and going to church and being sick—were considered nonwork activities

The time allocated to these activities, in different seasons, was cross-tabulated for different demographic groups (adult females, adult males, and children) and for private farms and the collective farm This approach allowed the investigation of the uses of residual time and the consideration of three types of labor-use variations seasonal variations, interhousehold variations (private farm households versus collective farm households), and intrahousehold variations (variations among different demographic groups)

General Patterns of Labor Use in the Study Area

Labor use in the study area can be categorized according to the sources and uses of labor Four types of labor can be distinguished household labor, hired labor, community labor, and collective labor Household labor is the single most important source of labor in the private sector A more-or-less clearly defined division of labor by sex and age exists among household members Women are primarily responsible for household-maintenance activities These activities are regular, numerous, and often overlapping Women s labor is rarely associated with animal power and the use of heavy tools Most of women s activities are restricted to the confines of the homestead Some of the daily chores, such as preparing food, caring for children, brewing spinning, and churning milk, are carried out exclusively by women with the assistance of children Women also participate in productive activities such as weeding, harvesting, and making handicrafts Men are largely responsible for the production of food, both for cash and subsistence This situation contrasts with conditions in other sub-Saharan African countries where subsistence crop production is largely women s domain In the study area, clearing land, preparing soil, planting, and constructing fences are undertaken exclusively by men

Hired labor, though forbidden by law, is widely used in the study area It is possible to distinguish permanent and temporary workers Permanent workers are usually shepherds and are paid in kind or in cash Occasionally, adults are hired permanently for field work Permanent workers live and eat under the same roof as their employer Temporary workers are hired on a contract basis during peak seasons, especially the harvest season when labor is required to mow teff Households use hired labor so that they can finish harvesting before the rains begin Households also use hired labor so that they can get to the threshing grounds before other households Since 1983 when the threshing grounds became common property a shortage of threshing ground has been experienced in the area

A separate study was undertaken to determine the extent of the use of hired labor in the area A sample of nine households (4 6% N = 195) indicated that 63% of the cropped areas was harvested by hired workers Hired workers can harvest a given field substantially faster than the employer The employers suggested that the hired workers are faster because they can work from dawn to dusk, whereas the household members have to attend social obligations

Traditionally, community labor was used to cope with seasonal labor shortages through labor exchanges However, this type of labor is not used on the cooperative farms and its importance in the private sector has been declining

Collective labor is used on the cooperative farm The labor-use and income-distribution systems are subject to the Ministry of Agriculture s official guidelines The basic means of production—land oxen, and farm tools—are owned in common The decisions about what and how to produce are collectively made under the close supervision of development agents assigned by the Ministry of Agriculture The cooperative in Oudie village has adopted a fixed work schedule of 8 hours a day Until recently, it distributed income on the basis of work-points accumulated by members, irrespective of the quality of work In the 1987 agricultural year, the 77 members (of which five were women) accumulated a total of 130,947 work-points The value of one work-point was EB 0 30, based on the Agricul-

tural Marketing Corporation's farmgate price. With in 8 hour working day the daily return to labor was EB 2 40. The average income of the members of the cooperative farm in that year was EB 510. The average income of the female members of the cooperative was 3 3% below the overall average. In 1987 the cooperative was attempting to reorganize its labor force so that payment would be made according to the quality and quantity of work performed.

Estimates of Residual Labor

The statistical results suggest the existence of varying degrees of residual labor with respect to labor required for crop farming depending on the assumptions underlying the model used.

Using the basic model the proportion of residual labor was estimated at 78% of the available labor for private farms and 66% for the cooperative farm. The model adjusted for the degree of participation in field work by women estimated the proportion of residual labor at 71% for the private farms and 55% for the cooperative farm. The estimates were further reduced to 65% for private farms and 55% for the cooperative farm when shepherds were excluded from the available labor force. When the labor that was available on the cooperative farm was compared to the labor that was used the proportion of residual labor in the available labor was only 17 6%.

Similarly the number of residual workers per year (in man equivalents) varied among the sectors, ranging from 260 to 139 for the private farms and 123 to 77 for the collective farm depending on the method of estimation (table 1). The number of residual workers per household (per year in man-equivalents) ranged from 2 1 to 1 2 for private farms and from 1 7 to 1 0 for the cooperative farm, depending on the method of estimation.

The proportion of residual labor is considerably lower on the cooperative farm. This may be due to the high land/man ratio on the cooperative farm and the use of tractors to plow. In addition the average age of cooperative members was 37 years while that of private peasants was 51 years. The available labor on the cooperative farm was limited by the smaller number of children over 7 years old and the relatively large number of unmarried men.

This analysis suggested the existence of about one man equivalent of residual labor per household in a year. However the results of the time allocation study suggest that the labor that seems to be redundant is in fact necessary subject to seasonal variations and clearly defined social and cultural norms.

Table 1 Estimates of residual labor Oudie Village, Ethiopia 1987-88

	Basic model	Model adjusted for degree of participation	Model adjusted for animal care	Expected labor time less time actually used
Residual labor (man days)				
Private	54 157 2	36 123	29 051 6	
Cooperative	31 836 0	20 174 4	19 839	3 498
Residual workers[a] (man equivalents)				
Private	260 0	174 0	139 0	
Cooperative	123 0	78 0	77 0	13 0
Proportion of residual labor (%)				
Private	78 0	71 0	65 0	
Cooperative	66 0	55 5	54 5	17 6
Residual labor per household (man days)				
Private	447 6	298 5	240 1	
Cooperative	430 2	272 6	268 1	47 0
Residual workdays per household (man equivalents)				
Private	2 1	1 4	1 2	
Cooperative	1 7	1 1	1 0	0 2

[a] Estimated by dividing the residual labor (in man days) by the net working days per year (208 for the private sector and 2 548 for the cooperative farms). In the private sector Saturdays are often considered as market days while in the cooperative farms Saturdays are normal working days.

Table 2 Average time allocation during the peak season (hr/day) Oudie Village, Ethiopia, 1987-88

Activity	Adult female		Adult male		Children		
	Private	Cooperative	Private	Cooperative	Private	Cooperative	Total
Directly productive activities							
Agricultural work	1 50	4 34	5 05	5 09	2 78	1 27	3 10
Animal care	0 28	0 12	1 70	0 41	5 24	1 4	2 01
Handicraft	0 38		0 02		0 32	0 01	0 17
Household maintenance activities							
Child care	0 53	0 90	0 02	0 92	0 57	1 73	0 62
Food preparation	2 69	2 27			0 63	0 42	1 00
Fuel gathering	0 49	0 31	0 01		0 26	0 36	0 26
Water fetching	0 35	0 57		0 01	0 06	0 46	0 22
Going to mill	0 48	0 37	0 14	0 26	0 03	0 30	0 24
Other	1 45	0 41	0 78	0 24	0 45	0 26	0 67
Nonwork time							
Personal hygiene	0 44	0 24	0 20	0 24	0 41	0 50	0 36
Visit	1 24	0 81	1 17	1 21	0 42	1 38	1 00
Mourning and funeral	0 89	0 71	0 86	0 67			0 47
Conversation	0 38	0 58	0 53	0 44	0 47	1 77	0 68
Eating meals	0 55	0 66	0 77	0 64	0 72	0 72	0 68
Drinking coffee	0 21	0 16	0 62	0 16	0 05	0 02	0 20
Rest	0 57	0 31	0 62	0 51	0 12	1 17	0 53
Prayers and going to church			0 17				0 03
Sickness	0 09			1 36			0 16
Miscellaneous	0 25	0 14	0 29	0 40	0 09	0 06	0 19
All activities	13 06	12 09	12 95	12 68	12 61	11 83	12 67

Time Devoted to Various Tasks

The time-allocation study found wide seasonal differences (tables 2 and 3) Directly productive activities dropped from an average of 5 4 hours a day during the peak season to 3 5 hours a day during the slack season The average time allocated to agricultural work—crop farming—dropped sharply from 3 1 hours a day during the peak season to 1 hour a day during the slack season

On the other hand, time devoted to activities such as caring for animals, miscellaneous activities, gathering fuel, fetching water, and other household maintenance activities increased from 3 hours a day during the peak season to 4 2 hours a day during the slack season Making fences and gathering fuel were the two most important activities during the slack season Marketing, preparing food, and fetching water also received increased attention during the slack season The amount of time devoted to making handicrafts and going to the mill remained constant

Contrary to expectations, time devoted to nonwork activities, which were presumed to have a strong leisure component, did not increase much during the slack season The amount of time spent resting and taking care of personal hygiene and resting also remained constant

The nonsleeping time showed a slight increase from 12 7 hours a day during the peak season to 13 2 hours a day during the slack season, tentatively suggesting that people sleep for a shorter amount of time when they are not engaged in hard work

Thus, the agricultural slack season was not an idle time, but instead was a time when other directly productive activities, such as caring for animals and making capital investments received more attention Especially for women, the slack season did not necessarily mean more leisure time Activities that are considered the domain of women—preparing food, caring for children, and fetching water—are not seasonal

Fairly effective utilization of the available labor is possible due to the existence of many different tasks distributed over the year The mixed-farming system of highland Ethiopia requires labor throughout the year As Hard (1935) observed, If there are not turnips to be hoed, there are cows to be milked, if there are not cows to be milked, there are turnips to be hoed there is always something to be done on the farm "

Table 3 Average time allocation during the slack season (hr/day) Oudie Village Ethiopia 1987-88

Activity	Adult female		Adult male		Children		Total
	Private	Cooperative	Private	Cooperative	Private	Cooperative	
Directly productive activities							
Agricultural work	1 17		2 94	3 07	0 83	0 07	1 02
Animal care	0 47	0 21	2 92	1 05	4 60	2 14	2 34
Handicraft	0 28	1 19			0 03		0 17
Household maintenance activities							
Child care	0 38	1 05	0 11	0 17	0 45	0 68	0 44
Food preparation	2 73	1 61			0 87	0 79	1 12
Fuel gathering	0 99	1 15	0 01		0 51	2 54	0 87
Water fetching	0 82	0 89			0 20	0 72	0 45
Going to mill	0 26	0 69	0 14		0 19	0 06	0 21
Other	2 82	2 48	0 19	0 37	0 65	0 32	1 15
Nonwork time							
Personal hygiene	0 29	0 42	0 24	0 53	0 43	0 57	0 41
Visit	0 76	1 29	1 29	2 74	0 56	1 41	1 11
Mourning and funeral	0 62	0 54	1 23	1 72	0 09		0 56
Conversation	0 25	0 47	0 47	0 82	0 80	0 30	0 31
Eating meals	0 60	0 92	0 94	0 92	0 84	1 04	0 85
Drinking coffee	0 88	0 64	0 46	0 44	0 05	0 03	0 38
Rest	0 58	0 20	0 50	0 65	0 43	0 71	0 52
Prayers and going to church			0 19		0 05		0 04
Sickness	0 13						0 03
Miscellaneous	0 42	0 24	2 00	1 38	1 62	1 48	1 24
All activities	13 45	13 99	13 68	13 86	12 57	12 86	13 22

In the private sector directly productive activities were carried out mainly by men and children The two most important components were crop farming and animal care Travel to fields accounted for 9% of the time allocated to crop farming

Individuals on private farms allocated their time differently than members of the cooperative farm did Women on the cooperative farm spent on average, as many as 4 5 hours on directly productive activities during the peak season These women spent only 4 8 hours a day on household-maintenance activities which was less than the 6 hours a day that women in the private sector spent on these activities In an attempt to ameliorate labor shortages the cooperative farm has tried to mobilize women to work in the fields and pays them on a work-point basis for doing so Labor shortages are more intense on the cooperative farm due to the high land man ratio the difficulties in openly using hired labor and the rigidity of the time schedule for the cooperative

Children performed many directly productive activities especially animal care Children in the private sector spent a greater proportion of their time in these activities than anyone else did Animal care is an indivisible task it requires one person regardless of their age or gender and it often overlaps with other tasks, such as playing and making hats In addition children participate in crop farming and housework Children participate in more housework during the slack season The daily average amount of time that children devoted to household-maintenance activities increased from 2 hours (private) and 3 5 hours (cooperative) during the peak season to 3 hours (private) and 5 1 hours (cooperative) during the slack season

Men rarely participated in housework Even during the slack season men did not help women Tasks such as food preparation and child care were never done by men during the study period The only type of housework that was done by men was slaughtering animals The time-allocation study also revealed that men almost invariably devote more time to nonwork than women and children do

This study demonstrated that directly productive activities were not the only useful activities Household-maintenance activities were important for the survival of the household Most of the activities categorized as nonwork were either socially or physiologically useful Under these circumstances it was difficult to determine the amount of pure leisure time available to households The

boundary between work and leisure was blurred Moreover, seasonal unemployment was not conspicuous in the study area

Conclusions

This study assumed that conventional methods overestimate surplus labor and underestimate the contributions of women and children to the survival of the household Both quantitative and qualitative methods were used to show that it is questionable whether there is a labor surplus in Ethiopia The existence and magnitude of labor underutilization depend on the underlying definition and assumptions about the relevant variables Using a broad definition of work, it was demonstrated that labor underutilization is often overestimated labor shortages rather than labor underutilization, exist in the study area The major factors indicating the existence of labor shortages are long working hours (about 13 hours a day), the widespread use of hired migrant labor especially during peak seasons, extensive use of child labor, especially for animal care and the existence of overlapping activities in housework The study revealed that everybody, including young children, was busy almost throughout the year

However, disguised unemployment may exist in the study area Many of the activities designated as necessary may have leisure components For example, rest may be both time for regaining energy after hard work and time spent idling Disguised unemployment can manifest itself in a leisurely pace of work arising from the practice of work-stretching and work-sharing by family members The high frequency of certain nonwork activities, such as visiting friends, conversing, and drinking coffee may indicate the existence of disguised unemployment Additional disguised unemployment might be discovered through a study of interhousehold variations in technical efficiency of labor use

The time-allocation study also revealed patterns of the gender division of labor in the study area To a considerable extent, women's and children's labor was substitutable and complementary This point suggests that further research is required to investigate the tenability of the hypothesis that women in the agricultural households must have a pronatalist incentive" (Yotopoulos and Mergos 1986) Childbearing may be the most effective way available for rural women to reduce the backbreaking arduousness of household maintenance activities However, further research is required to determine the relationship between the demand for children as herders and parents' preferences for schooling

Household maintenance, an activity that was primarily done by women with the assistance of children, was composed of numerous, regular, and often overlapping daily chores of short duration but high frequency per unit of time Moreover, the amount of time required for housework was irreducible beyond a certain technically and culturally determined minimum level, even during slack seasons On the other hand, the existing gender-division of labor was so rigid that men were rarely involved in housework This implies that, under the given circumstances there is a limit beyond which women's labor cannot be mobilized for farm work without reducing the welfare position of the household

Women were involved to a limited extent in food production The gender division of labor in farm work can be considered gender-sequential (Ellis 1988, 178-179) or task-specific Women s labor in the field is largely restricted to certain tasks such as weeding and harvesting Women do not engage in other activities, such as plowing Therefore, women are not in a position to produce crops on their own This suggests that women s labor is undercounted by statisticians Moreover, the study suggests that rural development designers and practitioners should pay more attention to the role of women and children in rural development

In the study area, women are neither confined to the house nor do they dominate either subsistence- or cash-crop production Ester Boserup's dichotomy of male and female farming systems in Africa has little relevance to the conditions of this area

In a rural setting characterized by a semi-subsistence economy and an imperfect labor market, it is unrealistic to explain existing patterns of the gender division of labor in terms of the principle of comparative advantage, which says that gains from specialization are generally sufficient to explain why men do not participate in household work Instead, the most likely explanatory variables determining the gender division-of-labor patterns in the

study area are social and cultural norms, type of farm technology cropping patterns, and the physical environment

Literature Cited

Brown Maxwell 1979 *Farm budgets from farm income analysis to agricultural project analysis* Baltimore Johns Hopkins University Press

Central Statistical Office 1985 *Rural labour force survey April 1981 April 1982* Statistical Bulletin No 51 Addis Ababa

Ellis Frank 1988 *Peasant economics Farm households and agrarian development* Cambridge Cambridge University Press

Ghosh B N 1977 *Disguised unemployment in underdeveloped countries (with special reference to India)* New Delhi Heritage Publishers

Hard Louise E 1935 *Labour in agriculture An international survey* London Oxford University Press

International Labour Organization 1971 *Concepts of labour force under utilization* Employment Research Papers Geneva

Kao Anscell and C Eicher 1964 Disguised unemployment in agriculture A survey In *Agriculture in economic development* ed C Eicher and L Witt New York McGraw Hill

Lal Deepack 1976 Supply price and surplus labor Some Indian evidences *World Development* 4(10/11) 889 905

Lewis W Arthur 1954 Economic development with unlimited supplies of labour *Manchester School of Economics and Social Studies* May pp 139 92

Mathur A 1964 The anatomy of disguised unemployment *Oxford Economic Papers* 16(July) 161 93

Mehra S 1966 Surplus labour in Indian agriculture *Indian Economic Review* (April)

Nurske Ragnar 1955 *Problems of capital formation in underdeveloped countries* Fair Lawn New Jersey Oxford University Press

Nurske Ragnar 1957 Excess population and capital construction *Malayan Economic Review* 2 1 11

Pepelasis A A and P A Yotopoulos 1962 *Surplus labour in Greek agriculture 1953 1960* Athens Center of Planning and Economic Research

Robinson Joan 1936 Disguised unemployment *Economic Journal* 46(June) 225 37

Rosenstein Rodan P N 1943 Problems of industrialization in Eastern and Southern Eastern Europe *Economic Journal* 53 202 11

Schultz T W 1964 *Transforming traditional agriculture* New Haven Yale University Press

Sen A K 1975 *Employment technology and development* Oxford Clarendon Press

Wellisz S 1968 Dual economics disguised unemployment and unlimited supplies of labour *Economic Journal* 35 22-51

Yotopoulos P A 1967 *Allocative efficiency in economic development A cross section analysis of Epirus farming* Athens Center of the Planning and Economic Research

Yotopoulos P A and George J Mergos 1986 Family labor allocation in the agricultural household *Food Research Institute Studies* 20(1) 87 105

Effects of Exchange-Rate Liberalization and Input-Subsidy Removal on the Competitiveness of Cereals in Ghana

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SUMMARY

Exchange-rate liberalization and the deregulation of input and output markets have been central to the Structural Adjustment Program employed by the government of Ghana to stimulate economic growth This paper focuses on the effects of exchange-rate liberalization and removal of input subsidies on the productivity and competitiveness of cereals

Based on primary and secondary data on the cereal subsector, levels of farm productivity for various cereal production technologies, measures of protection and comparative advantage, and the effects of flexible exchange rate on relative prices of cereals were analyzed for 1986 to 1992 The study shows that exchange-rate liberalization and the removal of agricultural input subsidies have had substantial impact on cereals in Ghana

The productivity of land under cereal cultivation, on the average, increased between 1986 and 1988 when the most important agricultural inputs (fertilizers, machinery, etc) still benefited from some levels of subsidy However, between 1988 and 1992, land productivity generally declined as farmers reduced use of inputs due to their high cost after the liberalization policy was implemented Also, high production costs and the subsequent decrease in productivity resulted in a worsening of the financial returns per hectare to maize and rice farmers in particular

The protection enjoyed by cereals produced in Ghana has been eroded as well For rice nominal protection declined from 54% in 1988 to 20% in 1992, and for maize a 10% nominal protection in 1988 changed to an implicit tax of 1% by 1992 The nominal protection for sorghum and millet also declined from more than 40% in 1988 to only 4% in 1992 Moreover high input cost resulted in all cereals except rice moving from positive effective protection (about 33% for mechanized maize and more than 70% for improved sorghum and millet) in 1988 to taxation by 1992 (35% implicit tax on maize and 6% on sorghum and millet)

In terms of competitiveness, the effect of liberalization and input-subsidy removal on cereals in Ghana has been mixed Whereas the competitiveness of sorghum and millet improved between 1988 and 1992 both at the farmgate and wholesale levels (probably because they require fewer imported inputs), maize and rice showed deterioration in competitiveness at the wholesale level Moreover, the cereal price relatives showed that these policies, which tend to protect the importable cereal (rice), adversely affected the production of the exportable cereal (maize)

The analyses imply that government's objective of increasing cereal productivity to attain food self-sufficiency and food security suffered a setback under the liberalization policy

because it resulted in a resource squeeze on the cereal subsector If the government continues to pursue productivity increases for cereal farmers as a policy objective, it will be necessary to introduce some type of selective subsidy that is both input and crop specific and that also encourages private-sector participation

Between 1960 and 1980 Ghana s economy was characterized by frequent changes in government and lack of coherent and consistent policy measures resulting in gross macroeconomic mismanagement Per capita income declined by more than 30% An overvalued currency caused imports to rise as exports declined resulting in a worsening balance of payments position and rising external debt (a situation that was aggravated by declining world commodity prices) The unfavorable macroeconomic environment adversely affected the productive sectors of the economy causing shortfalls in food production particularly cereals (Asiedu-Saforo 1989)

In response to the persistent economic decline of the 1970s and early 1980s the government instituted the Economic Recovery Program (ERP) in 1983 A major focus of the ERP and the associated Structural Adjustment Program (SAP) in the 1980s was food self sufficiency particularly for cereals At the same time the SAP emphasized economic liberalization that deregulated financial input and output and labor markets This paper examines the extent to which exchange-rate liberalization and input subsidy removal (which are integral components of the economic liberalization policy) have affected the competitiveness of cereals in Ghana and food self sufficiency objectives

A basic philosophy behind the ERP and SAP has been that the negative growth of real gross domestic product in the 1970s and early 1980s resulted from policy induced distortions (Chand and van Til 1988) Therefore by adopting relevant policy measures and removing the distortions, the economy could move to its production possibility frontier A major strategy of the program has therefore been to realign relative prices to provide incentives to the productive sectors of the economy This was to be achieved through exchange rate fiscal monetary trade and payments policies Besides the large and repeated devaluations of the cedi which have become the centerpiece of the reform program the relative prices of large number of items have been realigned For example the price of cocoa, Ghana s major export crop was repeatedly revised upwards, while subsidies on farm inputs (fertilizer seed, machinery etc) and support prices for certain foodcrops (maize, rice) were abolished by the end of the 1980s

Because the bulk of agricultural output in Ghana comes from small-scale farmers and because agriculture is the largest sector of Ghana's economy, the effect of policy reforms on small-scale farmers, particularly food-crop farmers strongly influences aggregate agricultural output For example, successive currency deprecations under the exchange-rate liberalization policy have increased the domestic cost of agricultural inputs beyond the reach of most small-scale farmers The extent to which such developments (e g , high production costs) have affected smallholder productivity as farmers adopt improved technological packages most of which include imported technology (e g fertilizer) are still obscure to the economist and policy maker Also because the ability of smallholder food producers to achieve their objectives of profit maximization or at least satisfy their subsistence and food security needs is affected by the prevailing policy environment, it is crucial to closely examine the policy-productivity linkage in the food sector More specifically the competitiveness of foodcrops, and cereals in particular, may either be enhanced or adversely affected by the economic liberalization policy This paper attempts to provide empirical evidence of the policy effects of the liberalization of exchange rate and the removal of agricultural input subsidies on the productivity and competitiveness of cereals in Ghana

The study addresses several questions relevant to government objectives of increased agricultural productivity and food self sufficiency To what extent has exchange-rate liberalization affected the level of protection and competitiveness of cereals produced in Ghana? By how much has removal of subsidies on agricultural inputs increased or decreased smallholder productivity and therefore aggregate agricultural output?

The objectives pursued in this paper thus are

- to determine the competitiveness of cereals (maize, rice, sorghum, and millet) produced in Ghana and how these cereals have been affected by exchange-rate liberalization and input-subsidy removal policies
- to determine the level of protection for cereals generated under the economic liberalization policy
- to estimate by how much the agricultural input-subsidy removal increased the production costs of cereals in Ghana, and therefore its effect on productivity

To address the above issues, the following were hypothesized

- Exchange-rate liberalization has enhanced the competitiveness of cereals in Ghana
- The economic liberalization policy (i e , removal of input subsidies and administered output prices) has eroded the protection enjoyed by cereal farmers in Ghana
- Agricultural input-subsidy removal has increased the cost of production of cereals and thereby reduced farmer productivity

It should be noted that changes in protection reflect changes in (a) exchange rates, (b) domestic output prices, (c) international prices, and (d) port, transport, and distribution charges In addition changes in exchange rates alone could substantially change levels of protection (Salinger 1986a) Similarly, competitiveness of cereals may be enhanced or reduced as a result of the above factors, in addition to changes in farmer productivity However, large changes particularly in exchange rates usually obscure productivity changes

Cereal Production in Ghana

In Ghana traditional small-scale farmers produce most foodcrops (cereals, roots and tubers, vegetables) and cash crops (cocoa coffee, pineapples, etc), even though large-scale commercial farming exists in many areas Traditional small-scale farmers produce for household consumption and the market, and their operations are characterized by limited (or negligible) capital base, low-level inputs consisting mainly of hand tools, and unimproved seeds from the previous harvest Land is generally abundant, and access to land is not a major constraint except in isolated locations particularly in forest areas However, household farms are usually less than a hectare in size Although much work has been done in recent years to introduce modern technology to farmers technological innovation among traditional small-scale farmers occurs so slowly that its impact is not easily ascertained or noticed For example, the prevalence of shifting cultivation obscures the minimal advances made in the introduction of modern intensive farming practices to traditional small-scale farmers in Ghana

Large-scale farming using modern methods (machinery, agricultural chemicals, improved seeds, etc) is practiced mainly in the savanna zones of the country (coastal savanna and northern savanna) and produces entirely for the market The savanna has fewer trees and therefore is conducive to the use of machinery Cereals mainly maize and rice are cultivated in these zones in large fields using modern technology even though small-scale farming is the predominant practice

Cereals are produced in all 10 administrative regions of Ghana However five ecological zones (based on environmental conditions and soil types) may be distinguished the coastal savanna, the northern savanna, the transitional zone (forest-savanna transition), the semi-deciduous rainforest and the high rainforest

A large variety of crops (both for food and cash) are therefore cultivated by farmers Monocropping is common with tree crops while foodcrops are usually grown under mixed-cropping systems except in areas where maize and rice are highly commercialized The concentration of production of specific cereals tends to follow the agro-ecological zones

Maize is produced in all zones both as subsistence crop and cash crop But the commercialization of the crop is concentrated in the transitional zone where it is cultivated more as a monocrop on fields averaging about 3 hectares per farmer, though a few farms may cultivate up to 100 hectares or more Cultivation is usually done in two crop seasons (major and minor seasons) except in the north where the unimodal rainfall pattern allows only a single annual cropping Where maize production is predominantly for subsistence it is usually mixed with sorghum millet and cassava

(in the North) or with cassava cocoyam, and plantain (in the transitional and forest zones)

Rice cultivation is common in all agro-ecological zones but predominant in the northern savanna zone (mainly upland rice) and coastal savanna zone (irrigated rice) Rice cultivated in the northern savanna zone is usually grown on large fields, averaging 20 hectares per farm, and mechanized This zone accounts for more than 60% of the rice produced in the country In the coastal savanna rice is cultivated mainly under irrigation (the north also has much rice under irrigation) and is highly commercialized Valley bottom rice cultivation is becoming increasingly important in the forest areas

Sorghum and millet are cultivated under similar agro ecological conditions and predominate in the northern savanna zone though they are marginally produced in the transitional zone Cultivation is mainly around houses and in small fields averaging less than a hectare per farm Even though pure stands of sorghum or millet are not uncommon these crops are usually cultivated with maize and cassava

Cereals among the Major Foodcrops in Ghana

Maize rice, sorghum, and millet the four main cereals produced in Ghana constitute a major component of the country s foodcrop subsector Maize is the major staple food It accounts for 55% of all cereals produced in Ghana Sorghum (contributing 20%) millet (16%), and rice (9%) follow in that order The other major foodcrops are plantains and roots and tubers notably cassava, yams, and cocoyam

Table 1 indicates that rice showed a modest 3% annual growth from 1970 to 1990 the highest among all the cereals even though production declined by about 2% per year in the late 1970s The average growth rate for maize for 1970 90 was less than 1% and production actually declined between 1970 and 1980 Sorghum and millet production fell by 1 3% and 2 3% per year, respectively during 1970-90 On the other hand, it should be noted that maize production increased significantly between 1980 and 1990, growing at over 5 6% annually Among the other major foodcrops produced in Ghana, production of plantain yam and cocoyam declined during 1970 90, and cassava showed a minimal growth rate less than 1% On the average therefore cereals seemed to have performed better in terms of production increases over the 20-year period than other major foodcrops Also, the growth rate figures indicate that except for maize the output of cereals in 1990 had not significantly changed from the 1980 levels

Rice is the most important cereal import About half the rice consumed in Ghana each year is imported (commercial imports and food aid) This is significant because rice consumption in Ghana is growing particularly among urban dwellers

Maize importation is minimal It is usually done (more often in the form of food aid) to meet emergency needs Since 1985 there has been no maize importation aside from 1987 when only 10,000 tons were imported On the other hand Ghana exported about 20,000 tons of maize to Angola in 1990, indicating that the country could become a net exporter of maize if the economic environment improved in favor of maize production

Table 1 Production growth rates (%/yr) of major foodcrops in Ghana 1970-90

	1970 75	1975 80	1980 85	1985 90	1970 80	1980 90	1970 90
			Cereals				
Maize	-5 77	0 64	2 32	8 00	-2 66	5 62	0 74
Rice	8 98	-1 97	5 00	0 25	2 73	2 66	3 27
Sorghum	-5 46	3 11	3 72	-5 30	-1 66	-1 28	-1 34
Millet	-2 92	2 30	-2 35	-7 50	-0 38	-4 49	-2 34
			Other foodcrops				
Cassava	0 08	4 15	1 24	-2 33	2 13	-0 62	0 69
Plantain	-4 83	5 04	9 00	-8 16	-4 44	-1 42	-2 57
Yam	-4 40	-5 19	1 33	11 32	-4 22	6 70	-0 18
Cocoyam	-0 65	-4 57	1 23	-1 89	-2 54	-0 39	-1 41

Source *Agriculture in Ghana Facts and Figures* 1991

Overview of Agricultural Policy

Industrialization and modernization of agriculture have been the central economic policies of successive governments in Ghana s post-independence era Modern agriculture has been viewed as the source of cheap basic food as well as the foreign exchange essential for the purchase of industrial capital goods and raw materials Government food policies have emphasized the production of cereals and starchy staples for food self-sufficiency and the maintenance of buffer stocks to provide security against crop failure and other natural hazards

The first major agricultural policy reform occurred after independence in 1957 when the government of Kwame Nkrumah scrapped the second phase of a 10-year development plan (Five-Year Development Plan 1959-64) inherited from the colonial administration in favor of the new government's Seven-Year Development Plan (1963-70) The goal of the Nkrumah government was to develop Ghana on a socialist model, and the two basic pillars for this model were industrialization and modern agriculture Food production, particularly cereals was emphasized The overall increase in cereal production within the plan period was expected to be 52%

A second agricultural policy change occurred when Nkrumah s government was overthrown in 1966 The 7-year development plan of the Nkrumah government was shelved, and subsequently direct involvement of the state in industry and agriculture was discouraged Instead, a new 3-year development plan (1968-70) was launched The focus was to correct the disequilibrium in the system through import liberalization, devaluation of the cedi, and deflationary monetary and fiscal policies An effort was made to harness the potentials of the private sector for economic development Major components of this plan were setting up seed improvement and multiplication programs for food grains (mainly cereals) and the establishment of an agricultural development bank to provide credit to farmers Subsequent governments in the 1970s followed similar plans and promoted the production of cereals and other foodcrops

A third agricultural policy reform was initiated with the launching of the Economic Recovery Program (ERP) in 1983, and the associated Structural Adjustment Program under the government of the Provisional National Defense Council This occurred against a background of persistent economic decline of Ghana's economy in the late 1970s and early 1980s The rehabilitation phase of the ERP (1983-86) included a program for the agricultural sector *Ghana Agricultural Policy Action Plans and Strategies (1984 86)* (Ministry of Agriculture 1986) Highlights of the plan were self-sufficiency in the production of cereals, maintenance of adequate stocks of grains, particularly maize and rice, to ensure availability of food during the lean season (March-July), price stability, and provision of maximum food security against crop failure and other natural hazards The strategy of the government was to emphasize maize, rice and cassava during the 1984-86 period and increase productivity in high potential areas (including irrigated areas), while encouraging production in other areas

The second phase of the adjustment process (the stabilization phase, 1986-88) emphasized increased productivity and internal price stability in the agricultural sector Specific policy goals included attaining self sufficiency in cereals, starchy staples animal protein foods, and agro-industrial crops, maintaining buffer stocks for reasons of price instability and food security, improving storage, processing, and distribution systems in order to reduce post-harvest losses by 50%, increasing export of nontraditional crops, improving the performance of the livestock and fisheries subsector, strengthening the policy formulation capacity of the Ministry of Agriculture, improving agricultural research, credit, and marketing facilities, and ensuring high enough returns to efficient farmers to promote the adoption of improved technology to increase the productivity of Ghanaian agriculture to levels comparable to those prevailing at the international level (Ministry of Agriculture 1986) During the second phase of Ghana s adjustment program, the government actively promoted cereal production in pursuit of food security objectives For example, every year the government raised the guaranteed minimum prices for maize and rice, which had been in operation since the late 1960s, and subsidies of essential farm inputs such as fertilizers, machinery, and other agricultural chemicals continued, though on a reduced scale Also, although there had been continual depreciation of the

Table 2 Nominal exchange rates of the cedi (₵/US$), 1970-92 (December average)

Year	Official[a]	Parallel[b]	Auction / Interbank	Forex Bureau
1970	1 02	1 64		
1971	1 03	1 75		
1972	1 32	1 64		
1973	1 16	1 49		
1974	1 15	1 73		
1975	1 15	1 99		
1976	1 15	2 91		
1977	1 15	9 20		
1978	1 15	8 96		
1979	2 75	15 56		
1980	2 75	15 87		
1981	2 75	26 25		
1982	2 75	61 67		
1983	20 33	76 58		
1984	35 99	135 00		
1985	54 37	160 00		
1986	89 21	170 00	150 00	
1987		230 00	190 00	
1988			231 00	315 00
1989			302 00	345 00
1990			345 00	370 00
1991			389 00	398 00
1992			580 00	610 00

Sources Official rate Statistical Services Accra Parallel rate Sallnger (1986) Auction/Interbank and Forex Bureau rates Bank of Ghana Accra

[a] Exchange rate fixed by government regulation

[b] Exchange rate on the black market

cedi (a hub around which the entire adjustment process revolved) this was partially controlled as the government had an auction rate side by side with a Forex rate on the free market (table 2)

Under the third phase of the adjustment process (liberalization and growth phase) which started in 1989 the major goals included deregulation of commodity and service markets to reduce domestic price distortions as well as liberalization of export and import markets Government agricultural policy aimed at providing an enabling environment for the efficient production of food and agricultural raw materials at competitive world prices by encouraging those commodities and value added activities where Ghana has both comparative and competitive advantage (*Agriculture in Ghana* 1991) The food and agricultural development strategy of the government was set out in the document Medium Term Agricultural Development Program which has been widely publicized

As part of the liberalization program the guaranteed minimum prices for maize and rice were abolished and all subsidies removed including subsidies for agricultural inputs On the average the prices of most agricultural chemicals used in cereal production increased in excess of 40% per annum between 1986 and 1992 The cedi was allowed to float and find its own level in a free and competitive market and the cedi devalued (in nominal terms) from about ₵90 in 1986 to ₵580 per U S dollar in 1992 (table 2) Fertilizer importation and sales, for example, which hitherto had been under a government program, were privatized, and domestic prices of fertilizers doubled or tripled between 1990 and 1992

On the other hand importation of food commodities has been liberalized making imported rice in particular compete strongly with domestic rice Indications are that more rice has been imported since 1990 when the trade liberalization policy came into effect, but the statistics are not available to substantiate this

Thus both macroeconomic and sectoral policies have directly and indirectly influenced agricultural production resource use farm income and prices of agricultural inputs and outputs Although it is too early to assess the total response of farmers to these policy changes the high cost of agricultural inputs seems to have shifted resources away from agriculture (Asuming Brempong and Asante 1991) It is therefore not certain whether the objective of making the Ghanaian domestic market more competitive through liberalization has so far had any positive effect on the foodcrop subsector

Analysis and Discussion

The liberalization phase under the adjustment program in Ghana has been implemented based on the postulate that the fixed exchange rate system and restrictive trade practices impinge on the productive sectors of the economy (particularly agriculture) through their influence on relative prices and therefore resource allocation among sectors A flexible exchange rate within a competitive market framework on the other hand could provide the needed stimulus for growth and could move the economy to its production possibility frontier in all sectors Because cereal production is fundamental to the foodcrop subsector of Ghana s economy, liberalization in the agricultural input and output markets coupled with the effects of flexible ex

change rates at the macroeconomic level largely determine the level of incentives or disincentives to cereal production Levels of productivity at the farm level (for various technologies), measures of protection and comparative advantage, and the effect of flexible exchange rates on relative prices constitute the framework within which the effect of liberalization policies on cereal production in Ghana were analyzed

Data sources

The study used both primary and secondary data Primary data included a base-line survey of farms selected by random sampling from Ashanti, Brong Ahafo, Volta, Northern, Upper East, and Upper West regions—regions where cereal production is concentrated and that include areas where privatization of agricultural inputs was introduced earlier than in others (e g , Brong Ahafo) For example Northern, Ashanti and Brong Ahafo regions are noted for maize production while sorghum and millet production are confined mainly to the Northern, Upper East, and Upper West regions Also Volta (coastal savanna zone) and Northern regions are noted for rice production Secondary data included input and output prices that generated data for analyzing levels of protection competitiveness of cereals and the effect of exchange rates on price movements

Productivity

Agricultural productivity can be measured in terms of output per unit of land, labor, and capital as appropriate It is also possible to determine the extent of productivity by comparing the optimum output per unit of land with the actual output per unit of land This comparison indicates the unutilized potential available One can also use the potential population carrying capacity of agriculture as an indication of unutilized capacity and therefore resource availability (Dapaah 1989) In this analysis, productivity was measured in terms of output per unit of land (i e , yield), *ceteris paribus* This is based primarily on the notion that in Ghana, access to land, per se, is not a major constraint to cereal production Farmers therefore have the option of tapping the full potential of their farm lands by employing optimal levels of relevant inputs which invariably constitute their major constraints

Table 3 Average cereal yields in Ghana 1986-92 (kg/ha)

Production method	1986	1988	1992
	Maize		
Traditional		1 000	1 000
Improved (draft)	1 800	2 000	2 200
Advanced mech	2 400	2 500	
Tractor ownership			2 500
Tractor hire			2 500
	Rice		
Traditional	1 000	1 000	800
Improved (draft)	1 400	1 500	1 200
Mechanized	2 000	2 200	
Tractor ownership			1 800
Tractor hire			1 800
Irrigated	3 500	4 000	
Tractor ownership			4 000
Tractor hire			4 000
	Sorghum		
Traditional	600	1 000	800
Improved	1 100	1 200	1 350
	Millet		
Traditional	600	1 000	700
Improved	1 100	1 200	1 200

Sources For 1986 Salinger (1986a) For 1988 Asante Asuming Brempong and Bruce (1989) For 1992 field data
Note Most farmers reported their yields in bags per acre which were converted to kilograms per hectare

Table 3 shows that the productivity of land under cereals increased between 1986 and 1988, but declined between 1988 and 1992 particularly for the traditional production methods except for maize Even though the decrease in productivity was not substantial for the other production technologies, one would expect an increase in productivity between 1988 and 1992 a period of government policy aimed at increasing productivity and food self sufficiency Moreover, the 1992 crop year had good rainfall, which gave a boost to land productivity Otherwise the yields that year could have been much lower This poor performance was aggravated by falling commodity prices in real terms (table 4) Nominal prices for maize and rice doubled between 1986 and 1992 but the 1992 prices were only about half of 1986 prices in real terms Maize and rice farmers were therefore worse off in 1992 than in 1986 or 1988 On the other hand the nominal prices of sorghum and millet increased more than six-fold between 1986 and 1992 and their real values per ton were higher in 1992 than in 1986 (even though 1988 real values were much higher) indicating that growers of these crops were

Table 4 Nominal and real farmgate prices (₵/ton) of cereals in Ghana, 1986-92

	1986		1988		1992	
Crop	Nominal	Real	Nominal	Real	Nominal	Real
Maize	22 600	4 69	28 000	3 26	45 000	2 57
Rice	60 200	12 48	18 000	9 10	150 000	8 56
Sorghum	13 800	2 86	68 000	7 92	95 000	5 42
Millet	13 800	2 86	65 000	7 58	85 000	4 56

Source Computed from data from the Ministry of Agriculture Accra and Statistical Services Accra

better off in 1992 Probably as the prices of maize and rice increased consumers turned more and more to sorghum and millet which can be used as substitutes in many respects especially in the northern part of the country

Table 5 shows a worsening of the financial returns per hectare for maize and rice farmers Maize farmers, other than those using traditional methods, had deficits in both nominal and real financial returns For rice even though the financial returns per hectare were positive (except for farmers who did large-scale mechanized farming with their own tractors) they were much lower in 1992 than in 1986 and 1988 Even for sorghum and millet the financial returns per hectare increased by more than four times between 1986 and 1988 but were cut in half between 1988 and 1992

The relative production costs for cereals (table 6) follow the same trend except that there are no comparable figures for 1986 and 1988 The important point is that even though the price of cereals is the same on the average (because farmers sell in the same market) different production technologies incurred different costs to produce a kilogram of cereal For example maize produced by improved draft technologies cost ₵133 57/kg as compared with ₵110 89/kg on farms that were mechanized but hired tractor services for farm operations Thus farmers using hired tractor services for mechanization were better off The high production cost for cereals in 1992 may also be inferred from the fertilizer-maize price relationship In 1986 only 1 6 kilograms of maize was needed to buy 1 kilogram of nutrient but in 1991 3 4 kilograms of maize were needed to buy 1 kilogram of nutrient (table 7) With fertilizer prices rising in 1992, the ratio is still increasing

It should be noted that it is becoming increasingly difficult for farmers to purchase and operate tractors by themselves due to the high cost (the cost of a standard tractor plus basic implements increased from about ₵4 5 million in 1986 to more than ₵10 million in 1992) A few farmers continue

Table 5 Summary of nominal and real financial returns of cereals in Ghana 1986 92 (₵/ha)

	1986		1988		1992	
Production method	Nominal	Real	Nominal	Real	Nominal	Real
			Maize			
Traditional			–6 550	–0 76	26 988	1 54
Improved (draft)	11 675	2 42	3 464	0 40	–68 079	–3 88
Advanced mech	11 047	2 29	–9 003	–1 05		
Tractor ownership					–107 056	–6 11
Tractor hire					–44 499	–2 54
			Rice			
Traditional	12 781	2 65	33 932	3 95	16 647	0 95
Improved (draft)	20 725	4 30	27 555	3 21	17 607	1 00
Mechanized	–7 685	–1 59	238 653			
Tractor ownership					–22 925	–1 31
Tractor hire					13 823	0 79
Irrigated	67 399	13 97	170 795	19 90		
Tractor ownership					97 900	5 58
Tractor hire					158 359	9 03
			Sorghum			
Traditional	3 986	0 83	40 227	4 69	48 992	2 79
Improved	9 106	1 89	34 194	3 98	41 754	2 38
			Millet			
Traditional	3 986	0 83	27 151	3 16	29 132	1 66
Improved	9 106	1 89	29 065	3 39	9 560	0 55

Sources For 1986 Salinger (1986a) For 1988 Asante Asuming Brempong and Bruce (1989) For 1992 field data

Table 6 Relative production cost for cereals in Ghana, 1992

Production method[a]	Yield (kg/ha)	Total labor cost (₵/ha)	Farm cost (₵/ha)	Total distribution cost (₵/ha)	Total distribution cost (₵/kg)	Total production cost (₵/kg)
			Maize			
Traditional	1 000	59 400	67 975	33 213	33 21	112 06
Improved (draft)	2 200	51 000	200 199	35 868	35 89	133 57
Advanced mech						
Tractor ownership	2 500	46 200	245 914	22 142	22 14	126 89
Tractor hire	2 500	49 200	204 437	22 142	22 14	110 89
			Rice			
Traditional	800	63 600	79 393	29 713	29 71	205 00
Improved (draft)	1 200	56 400	129 173	36 638	36 64	227 37
Mechanized						
Tractor ownership	1 800	48 000	220 771	37 138	37 14	255 10
Tractor hire	1 800	48 000	183 816	37 138	37 14	220 89
Irrigated						
Tractor ownership	4 000	86 400	337 192	43 638	43 64	204 11
Tractor hire	4 000	86 400	297 206	43 638	43 64	186 61
			Sorghum			
Traditional	800	55 200	64 107	6 500	6 50	91 53
Improved	1 350	48 000	117 326	7 500	7 50	99 81
			Millet			
Traditional	700	57 600	663 66	7 500	7 50	107 71
Improved	1 200	48 000	116 863	7 500	7 50	110 29

Source Computed from field data

[a]Tractor ownership implies that the farmer owns and uses a tractor for farm operations Tractor hire means that the farmer does not own a tractor but hires tractor services for farm operations

to operate old and inefficient tractors at high cost, while most farmers depend on hiring tractor services (where available), which is comparatively cheaper Hence, the production cost differences between farms where farmers own tractors and those where tractor services are hired (table 6) Also, even though some techniques show negative returns for maize and rice (table 5), this may not seriously affect the farmer's operations because some inputs are not costed by farmers (e g , farmer s labor, family labor seed, etc) Thus the farmer usually looks only at his income over direct cash expenses and considers his activity profitable, at least in the short run However, for the analysis, all inputs have been costed (e g , family labor is given an imputed cost equal to hired labor, and child labor is assumed to cost half as much as an adult)

Table 7 Ghana Fertilizer/maize price relationship

Year	Maize price[a] (₵/kg)	Fertilizer price[b] (₵/kg)	Fertilizer/maize price ratio
1983	24 40	0 91	0 04
1984	11 80	7 35	0 62
1985	18 25	24 80	1 40
1986	27 10	43 00	1 59
1987	51 20	71 70	1 40
1988	45 50	127 10	2 80
1989	40 50	191 00	4 70
1990	69 80	240 50	3 40
1991	70 00	240 50	3 40

Source International Fertilizer Development Center 1991

[a]Average August to October (i e low price period)

[b]Avg per kg of nutrient for 15 15 15 and ammonium sulphate

Protection and comparative advantage

Smallholders, who produce the bulk of Ghana s agricultural output, are greatly influenced by the policy environment and the set of incentives it generates These incentives can be measured in terms of the financial returns per hectare, the return to family labor, nominal rate of protection effective rate of protection, domestic resource cost ratio, and the terms of trade between agricultural and nonagricultural sectors (Scandizza and Bruce 1980, Asuming-Brempong 1989, Asuming-Brempong and Flinn 1990) The incentive structure generated under the liberalization program was analyzed using a number of descriptive statistics, including the nominal protection coefficient (NPC), the effective protection coefficient (EPC), and domestic resource cost (DRC) [23]

[23]These indicators (NPC EPC and DRC) have been integrated in a Lotus 123 template that has the advantage of

The NPC (or nominal protection rate when measured in percentages) measures the deviation (or shortfall) of domestic wholesale prices from their world market or border prices An NPC greater than 1 implies that the domestic product is protected On the other hand, an NPC less than 1 indicates negative protection or taxation This may be expressed as follows

$$NPC_j = P_j^d / P_j^b \quad (1)$$

where NPC_j is the nominal protection coefficient for the jth commodity P_j^d is the domestic price of commodity j and P_j^b is the border price of commodity j (expressed in domestic currency)

The NPC is converted to percentages as nominal protection rate (NPR) to simplify interpretation by the formula

$$NPR = (NPC - 1)100 \quad (2)$$

The EPC (or effective protection rate when measured in percentages) is defined as the excess in domestic value added (at domestic prices) over free trade value added (at world prices) It indicates the combined impact of price policies on outputs and tradable inputs on producers incentives and therefore it reflects the incentive afforded for investment in an industry It can be expressed as $EPC_j = V_j^d / V_j^b$ where EPC_j is the effective protection coefficient on the jth activity V_j^d is the value added at domestic prices in the jth activity and V_j^b is the value added at world prices (or international prices) To facilitate computation the EPC may be decomposed into its output and input components as follows

$$EPC_j = \left(P_j^d - \sum_{i=1}^{k} a_{ij} P_i^d \right) / \left(P_j^b - \sum_{i=1}^{k} a_{ij} P_i^b \right)$$

where

a_{ij} = quantity of the ith input used to produce one unit of the jth output
P_i^d = domestic price of the ith input
P_j^d = domestic price of the jth commodity
P_i^b = border price of the ith input
P_j^b = border price of the jth commodity

An EPC greater than 1 indicates positive protection (i e the commodity enjoys an implicit subsidy on its inputs or protection on its price or both), while an EPC less than 1 implies taxation (or negative effective protection) The commodity is neither protected nor taxed when EPC is 1 When converted to percentages the EPC is called the effective protection rate (EPR) The formula for conversion is EPR = (EPC – 1)100

The DRC coefficient was employed as a measure of comparative advantage or international competitiveness of cereals produced in Ghana The DRC coefficient measures the opportunity cost of producing a unit of commodity by employing domestic resources rather than importing it DRC is usually expressed opportunity cost of domestic resources (in domestic currency) divided by net foreign exchange earned or saved (in foreign currency) or

$$DRC = \sum_{s=1}^{n} Y_s MP^b P^f / \left(P_j' - \sum_{i=1}^{m} A_{ij} P_i' \right)$$

where

Y_s = quantity of sth primary nontraded factor used in the production of a unit of the jth commodity
MP^f = marginal physical product of the sth input in its best alternative use b (or the domestic market price of the factor which is used as a surrogate when marginal products are difficult to compute as in this analysis)
P^f = domestic price of the sth input
P_j' = border price of the jth output (c i f for imports f o b for exports)
A_{ij} = quantity of traded input i used in producing one unit of the jth output
P_i' = border price of the ith traded input (c i f for imports f o b for exports

A DRC greater than 1 indicates an inefficient activity This means that it costs more in domestic resources to produce one unit of the product than it will cost to import the same unit On the other hand, a DRC less than 1 implies that the activity is efficient and should be encouraged A negative DRC however indicates negative value added at world prices

Levels of protection

The major determinants of the level of protection in the economy are domestic output prices, exchange rates international or border prices, and transport and other distribution charges Notwith-

interlinking components and being explicit in its assumptions concerning tax subsidy components as well as tradable nontradable cost breakdowns (Salinger 1986)

standing the limitations of the nominal protection measure (for example, it does not account for the effects of commercial policies on real exchange rates or changes in terms of trade, and it is limited to output prices and ignores the input side), it provides a convenient way of showing the divergence between domestic and international prices of commodities The nominal protection rate is only marginally positive for all cereals except maize, indicating that exchange-rate reform and changes in other variables have eroded most of the protection enjoyed by these crops over the years For example, in 1992 the level of protection for rice was only 20%, for sorghum and millet it was only 4%, and maize was taxed at the rate of 1% (table 8)

A more appropriate indicator of protection, which incorporates the effects of price interventions at both the input and output levels and the effects of commercial policies on real exchange rates, is the effective rate of protection It is defined as the percentage excess (or shortfall) of domestic value added over value added in border or world market prices at the shadow exchange rate There has been a marked deterioration in levels of effective protection enjoyed by all the cereals and this may be attributed mainly to the increase in input cost due to the market liberalization policy Except for maize (all production techniques) and improved millet production, all cereals enjoyed some minimal levels of effective protection in 1992 (table 8) Rice farmers who own tractors enjoyed the highest level of effective protection (35%), while millet produced using traditional technology was the least protected (3%) On the other hand maize farmers who owned tractors were taxed most (35%)

Comparative advantage

Comparative advantage is the ability of a country to produce a unit of a commodity at lower opportunity cost of the domestic cost of production (social and economic) employed than obtaining it by imports or some other means The indicator used as a measure of comparative advantage in this analysis is the domestic resource cost coefficient (DRC) The DRC measures the cost of domestic nontradable factors of production used to earn (export activity) or save (import-substitution activity) a net unit of foreign exchange

Among the cereals, sorghum and millet had DRC coefficients less than 1 at both the farmgate and wholesale levels, indicating that these crops are competitive, and that Ghana has comparative advantage in producing them This is a marked improvement in the performance of these crops over their 1988 levels A major reason may be that relatively fewer imported inputs are employed in producing them Rice and maize, however, show deterioration in their competitiveness at the wholesale level, even though they continue to be competitive at the farmgate for all techniques of production Maize production by improved draft technique showed the highest DRC value, 3 59, indicating that this technique of production is the most uncompetitive For rice, mechanized rice production where the farmer owned a tractor proved to be the most uncompetitive (DRC 2 49) mainly because the purchase cost and operating cost of tractors in Ghana are now prohibitive as a result of the liberalization of input and output prices This was also true with maize production where the farmer owned a tractor, in which case DRC was 2 48 (table 8)

Sensitivity analysis

A basic limitation of the DRC measure is that being static, it does not incorporate the effects of changes in the important variable over time One way to remedy this shortcoming is to conduct a sensitivity analysis to see what effect changes in these key parameters will have on the DRC estimates Even though yield, exchange rates, transportation rate, domestic and international prices of the commodity, and tradable inputs used to produce it are all key variables in DRC analysis, sensitivity analysis was done using yield and transportation rate only because of their importance under the present economic environment

Table 9 presents the combined effects of simultaneously increasing yield by 20% and reducing transportation rate by 10% on the levels of protection and comparative advantage of cereals The sensitivity analyses indicate that increasing yields and reducing the transportation (or distribution) cost of cereals in Ghana substantially improved their competitiveness by about 20% to 50% For

Table 8 Profitability protection and comparative advantage of cereals in Ghana 1992[a]

Production method[b]	Financial profit farmgate (₵/ha)	NPC	NPR (%)	EPC	EPR (%)	DRC		
						Farmgate	Rural market	Wholesale market
			Maize					
Traditional	26 988	0 99	–1	0 91	–9	0 42	0 51	1 19
Improved (draft)	–68 079	0 99	–1	0 73	–27	0 32	0 41	3 59
Advanced mech								
Tractor ownership	–107 056	0 99	–1	0 63	–35	0 43	0 56	2 48
Tractor hire	–44 499	0 99	–1	0 91	–9	0 39	0 49	1 61
			Rice					
Traditional	16 647	1 20	20	1 17	17	0 75	0 81	1 25
Improved (draft)	17 607	1 20	20	1 25	25	0 67	0 74	1 62
Mechanized								
Tractor ownership	–22 925	1 20	20	1 35	35	0 6	0 74	2 49
Tractor hire	13 872	1 20	20	1 24	24	0 48	0 58	1 61
Irrigated								
Tractor ownership	97 899	1 20	20	1 32	32	0 24	0 34	1 40
Tractor hire	158 358	1 20	20	1 32	32	0 17	0 25	1 03
			Sorghum					
Traditional	48 992	1 04	4	1 03	3	0 51	0 57	0 68
Improved	41 754	1 04	4	0 94	–6	0 39	0 47	0 62
			Millet					
Traditional	29 132	1 04	4	1 03	3	0 69	0 75	0 87
Improved	9 560	1 04	4	0 92	–8	0 54	0 62	0 78

Source Computed from field data

[a]NPC = nominal protection coefficient NPR = nominal protection rate EPC = effective protection coefficient EPR = effective protection rate DRC = domestic resource cost

[b]Advanced mechanized for 1986 and 1988 (for maize and rice) are equivalent to tractor ownership/hire for 1992 and irrigated rice for 1986 and 1988 are also equivalent to tractor ownership/hire (under irrigated rice) for 1992

Table 9 Sensitivity analysis Increase yield by 20% and reduce transport cost by 10%

Production method	Financial profit farmgate (₵/ha	NPC	NPR (%)	EPC	EPR (%)	DRC		
						Farmgate	Rural market	Wholesale market
			Maize					
Traditional	35 988	1 00	0	0 92	–8	0 32	0 40	0 96
Improved draft	–47 964	0 99	–1	0 86	–14	0 19	0 26	1 64
Advanced mech								
Tractor ownership	–84 147	1 00	0	0 81	–19	0 25	0 33	1 21
Tractor hire	–21 590	1 00	0	0 93	–7	0 24	0 32	0 97
			Rice					
Traditional	31 333	1 20	20	1 20	20	0 59	0 64	1 01
Improved draft	40 048	1 20	20	1 24	24	0 49	0 54	1 16
Mechanized								
Tractor ownership	10 933	1 20	20	1 29	29	0 39	0 49	1 41
Tractor hire	47 704	1 20	20	1 23	23	0 32	0 40	1 06
Irrigated								
Tractor ownership	172 601	1 20	20	1 28	28	0 14	0 22	0 92
Tractor hire	231 452	1 20	20	1 29	29	0 09	0 16	0 72
			Sorghum					
Traditional	64 192	1 07	7	1 06	6	0 39	0 45	0 55
Improved	67 832	1 07	7	1 00	0	0 27	0 33	0 46
			Millet					
Traditional	40 332	1 07	7	1 06	6	0 55	0 66	0 71
Improved	29 189	1 07	7	0 99	–1	0 38	0 45	0 57

Source Computed from field data See table 7

Table 10 Changing levels of protection for cereals in Ghana (1986-92)

Production method[a]	1986 NPC	1986 NPR (%)	1988 NPC	1988 NPR (%)	1992 NPC	1992 NPR (%)	1986 EPC	1986 EPR (%)	1988 EPC	1988 EPR (%)	1992 EPC	1992 EPR (%)
					Maize							
Traditional			1 10	10	0 99	–1			1 19	19	0 91	–9
Improved (draft)	1 35	35	1 10	10	0 99	–1	1 89	89	1 30	30	0 73	–27
Advanced mech	1 35	35	1 07	7			2 23	123	1 33	33		
Tractor ownership					0 99	–1	-				0 91	–9
Tractor hire					0 99	–1		-			0 65	–35
					Rice							
Traditional	1 32	32	1 47	47	1 20	20	1 42	42	1 65	65	1 17	17
Improved (draft)	1 32	32	1 54	54	1 20	20	1 76	76	2 22	122	1 25	25
Mechanized	1 32	32	1 54	54			1 95	95	2 90	190		
Tractor ownership					1 20	20					1 24	24
Tractor hire					1 20	20					1 24	24
Irrigated	1 32	54	1 54	54			1 76	76	2 04	104		
Tractor ownership					1 20	20					1 35	35
Tractor hire					1 20	20					1 24	24
					Sorghum							
Traditional	0 35	–65	1 43	43	1 04	4	0 29	–71	1 51	51	1 03	3
Improved	0 34	–66	1 43	43	1 04	4	0 25	–75	1 75	75	0 94	–6
					Millet							
Traditional	0 35	–65	1 52	52	1 04	4	0 29	–71	1 62	62	1 03	3
Improved	0 34	–66	1 52	52	1 04	4	0 25	–75	1 91	91	0 92	–8

Sources For 1986 Salinger (1986a) For 1988 Asante Asuming Brempong and Bruce (1989) For 1992 field data
[a]Advanced mechanized for 1986 and 1988 (for maize and rice) are equivalent to tractor ownership/hire for 1992 and irrigated rice for 1986 and 1988 are also equivalent to tractor ownership/hire (under irrigated rice) for 1992

example, the DRC for maize produced by traditional methods improved from 1 19 to 0 96, while mechanized rice, when the farmer owned a tractor, improved from 2 49 to 1 41 There was also some minimal reduction in both the level of protection (as in the case of rice) and taxation (as in the case of maize) The implication is that agricultural policies that encourage farmers to increase productivity and also reduce transport cost for inputs and outputs can improve the competitiveness of cereals in Ghana, particularly for maize and rice that are traded

Changing protection and comparative advantage

Economic incentive indicators computed at different points over time provide an approximation of the dynamic environment that is usually not captured in static analysis and allow comparative assessment to be made as variables change from year to year Table 10 shows that the protection for maize declined between 1986 and 1992 Mechanized maize production (the most common practice on commercial farms), which enjoyed a 35% nominal protection and 89% effective protection in 1986, was taxed at the rate of 1% nominal protection and 9% effective protection by 1992 The protection for irrigated rice, which increased from 32% nominal and 76% effective in 1986 to 54% nominal and 104% effective in 1988, declined to 20% nominal and 24% effective, on the average, by 1992 Sorghum and millet, however, moved from taxation at the rate of 66% nominal and 75% effective in 1986 to enjoy protection of more than 40% nominal and 70% effective in 1988 But this protection eroded quickly In 1992 improved sorghum and millet enjoyed only 4% nominal protection and were taxed about 6% It could be argued therefore that the major factors that precipitated the erosion of protection for cereals in Ghana, particularly between 1988 and 1992, were exchange-rate liberalization, which made the domestic cost of imported inputs such as fertilizer, machinery, lubricants, and agricultural chemicals rather high, the declining real domestic prices of cereals with the continual devaluation of the cedi, and the low yields of cereals

The DRC coefficients (table 11) show that cereal production was competitive at the farm level for 1986 to 1992 DRC estimates remained less than 1 throughout the period except for mechanized

maize and rice At the wholesale level the competitiveness of maize which improved between 1986 and 1988 by 20% to 40% (on the average) declined again by about the same margin between 1988 and 1992 The competitiveness of rice also improved between 1986 and 1988 but rice produced under irrigation became less competitive between 1988 and 1992 as DRC estimates increased from 0 79 to 1 03 or more The competitiveness of sorghum and millet worsened between 1986 and 1988 but improved between 1988 and 1992 as DRC decreased from over 1 on the average to less than 1 for all production technologies

The effect of policy changes on the competitiveness of cereals in Ghana has therefore been mixed between 1988 and 1992 Whereas the competitiveness of sorghum and millet improved the competitiveness maize and rice (which are the most important cereals) worsened probably because more imported inputs are used for producing maize and rice than for producing sorghum and millet

Exchange rates and the trade regime

The impact of the trade regime and exchange-rate policy may be estimated by relating domestic prices to the world prices (assuming that the prices paid to producers in the local market are the most relevant for the analysis) by Cassel s law or the law of one price ' as follows

$$P_i = P_r E_o (1-t_i)(1-k_i) \qquad (3)$$

or $P_i = P_r E_o F_i$, where

P_i = price paid to the exportable crop producer in domestic currency

P_r = world price of exportable crop in foreign exchange

E = nominal (or official) exchange rate

t_i = export tax

k_i = domestic parallel market price distortion

F_i = price distorting policy adjustment factor for exports

Similarly, if one considers food imports and how much they are sold on domestic parallel markets the price paid to farmers on these markets can be related to the world price as $P_i = P_r E_o (1 + t_i)(1 + k_i)$ or $P_i = P_r E_o T_i$, where P_i is price paid to importable crop producers in domestic currency P_r is world price of importable crop in foreign exchange t_i is import tariff rate T_i is price distorting policy adjustment factor for imports E_o is nominal (or official) exchange rate and k_i is domestic parallel market price distortion

The basic assumption is that we are dealing with

Table 11 Changing comparative advantage indicators for cereals in Ghana 1986-92

	DRC farmgate			DRC rural market			DRC wholesale market		
Production method[a]	1986	1988	1992	1986	1988	1992	1986	1988	1992
				Maize					
Traditional		0 68	0 42		0 76	0 51		1 72	1 19
Improved (draft)	0 59	0 40	0 32		0 53	0 41	1 97	1 39	3 59
Advanced mech	0 54	1 33			0 37		2 27	1 35	
Tractor ownership			0 39			0 56			2 48
Tractor hire			0 43			0 49			1 61
				Rice					
Traditional	0 77	0 58	0 75		0 64	0 81	1 67	1 22	1 25
Improved (draft)	0 71	0 61	0 67		0 70	0 74	1 90	1 73	1 62
Mechanized	1 59	0 27			0 35		8 16	1 52	
Tractor ownership			0 60			0 74			2 49
Tractor hire			0 48			0 58			1 61
Irrigated	0 34	0 17			0 22		1 24	0 79	
Tractor ownership			0 24			0 34			1 40
Tractor hire			0 17			0 25			1 03
				Sorghum					
Traditional	0 40	0 57	0 51		0 63	0 57	0 51	0 83	0 68
Improved	0 20	0 78	0 39		0 89	0 47	0 30	1 2	0 62
				Millet					
Traditional	0 40	0 80	0 69		0 89	0 75	0 51	1 2	0 87
Improved	0 20	0 80	0 54		0 91	0 62	0 30	1 23	0 78

Sources For 1986 Salinger (1986a) For 1988 Asante Asuming Brempong and Bruce (1989) For 1992 field data

[a]Advanced mechanized for 1986 and 1988 (for maize and rice) are equivalent to tractor ownership/hire for 1992 and irrigated rice for 1986 and 1988 are also equivalent to tractor ownership/hire (under irrigation) for 1992

Table 12 Regression results for cereal price relatives (Based on annual data from 1980-92 figures in parenthesis are *t*-ratios)

Dependent variable	Constant	Independent variables		R^2	D W [a]
		ln (P_y / P_x)	ln PCY		
ln (P_{z1} / P)	4 9423	0 515	–0 8325	0 50	1 87
	(0 9960)	(2 8871)	(–1 0104)		
ln (P_{z2} / P_x)	–0 6877	0 7966	0 0980	0 72	1 77
	(–0 1255)	(5 3315)	(0 1078)		

[a] Earlier D W estimates which indicated a higher degree of positive autocorrelation were corrected with the Cochrane Orcut procedure

Significant at the 1% level Significant at the 5% level

a small open economy producing three types of goods exportable crops importable crops, and nontradable crops Foreign prices, nominal exchange rates, export subsidies/taxes, and import duties determine the domestic nominal prices of traded goods Supply and demand factors (which are a function of trade and exchange-rate policies) determine the domestic nominal prices of nontraded goods

Now we can introduce the farmgate price (or producer price) of nontradables (P) and establish a structure of relative prices between traded and nontraded commodities

$$P_1 / P = (E_o / P)P_r(1 - t_1)(1 - k_1) \quad (4)$$

$$P_1 / P = (E_o / P)P_3(1 + t_3)(1 + k_1) \quad (5)$$

and

$$P_1 / P_1 = (P_1 / P_r)(1 + t_1)(1 + k_1) / (1 - t_1)(1 - k_1) \quad (6)$$

Equations (4) and (5) indicate that the real exchange rate provides a measure of the relative prices of importables and exportables to home goods in the economy Equation (6) implies that the domestic prices of importables relative to exportables depend on world prices, trade regime, and other policy measures (e g , tariffs)

Dornbusch (1974), Sjaastad (1980), Oyejide (1986), and Tshibaka (1986) have demonstrated that by adopting a three-sector model in which general equilibrium is implied in the nontraded goods market and relating it to equations (4), (5), and (6), we can establish a relationship (see Oyejide 1986 and Tshibaka 1986 for the theoretical derivation)

$$\ln (P / P_1) = a + b \ln (P_1 / P_1) + e \quad (7)$$

where a is a constant, b is the incidence parameter, and e is the error term The incidence parameter, b determines the induced change in the domestic price of nontraded goods relative to traded goods that has resulted from the change in domestic price of importables relative to exportables Thus b measures the effect of trade and exchange-rate changes and how the resultant changes in relative prices are shared among the sectors In the context of the food subsector of Ghana's economy, maize and rice are considered tradables and sorghum and millet nontradables

Although the effects of exchange rates and trade policies on agriculture may be broken down into two components—substitution effect and income effect—this analysis concentrated, due to data limitations, mainly on the substitution effect The estimated regression equations had per capita income (PCY) included as an additional explanatory variable because the time series data used violated the implicit assumption of constant income and productive capacity made for the model, equation (7) Thus the estimated equations are of the form

$$\ln P / P_1 = a + b \ln P_3 / P_1 + c \ln \text{PCY} + e$$

The movement of the domestic prices of these cereals both in absolute and relative terms, and the effect of exchange rates on the movement of these prices were estimated by regression analysis The results based on annual data for 1980 to 1992 are presented in table 12 P_1 is price index for maize (exportable crop), P_3 is price index for rice (importable crop), P_f is price index for sorghum, P_2 is price index for millet and PCY is per capita GDP at 1977 constant prices (as proxy for income) But PCY is not significant for any of the estimated equations, suggesting that its effect on cereal price relatives may be rather indirect

The estimated value of the incidence parameter is significant at the 5% and 1% levels, respectively, for the estimated equations (table 12) The parameter estimate of 0 52 implies that as a direct effect of trade and exchange-rate policies, the domestic price of sorghum relative to maize will increase by 0 52% as a result of a 1% rise in the domestic price of rice relative to maize (both of which are traded cereals) Similarly, the domestic price of millet relative to maize will increase by 0 80% as a result of a 1% rise in the domestic price of rice relative to maize Thus, for example, if the domestic price of rice (an importable cereal) increases by 1% due to the imposition of a tariff or some other trade pol-

icy it will generate an implicit tax of 0 80% on maize (a traded cereal) thereby reducing the relative incentive to produce maize and at the same time causing the price of millet (a nontraded cereal) to rise

Thus exchange-rate liberalization and trade policies which tend to protect the importable cereal (rice) have adversely affected the production of the exportable cereal (maize) and have reduced the incentive to produce maize relative to nontraded cereals (sorghum and millet)

Summary and Policy Implications

Ghana s Economic Recovery Program and the associated Structural Adjustment Program (SAP) have centered on exchange rate liberalization and the deregulation of input and output markets in all sectors of the economy Particularly in the third phase of the adjustment process which began in 1989 (the liberalization and growth phase) flexible exchange rates for the cedi were effected subsidies on agricultural inputs were removed and administered prices for major agricultural products (except cocoa) were abolished The macroeconomic environment generated under the SAP and its effect on small-scale farmers who produce the bulk of Ghana s agricultural output have direct implications for aggregate agricultural output, resource allocation among sectors, and foreign exchange earnings This study has attempted to provide some empirical evidence of the policy productivity, and competitiveness linkages in the cereal subsector of Ghana s economy More specifically, the effects of exchange rate liberalization and the removal of agricultural input subsidies on the productivity and competitiveness of cereals in Ghana have been examined

Levels of productivity at the farm level for various technologies of cereal production measures of protection and comparative advantage and the effects of flexible exchange rates on relative prices of cereals were analyzed Using primary and secondary data the study shows that exchange-rate liberalization and the removal of agricultural input subsidies together with other trade policies (e g , tariffs) have had substantial impact on the productivity and competitiveness of cereals in Ghana

The productivity of land under cereal cultivation, on the average increased between 1986 and 1988 when some of the most important agricultural inputs (fertilizers machinery etc) still enjoyed some levels of subsidy However, between 1988 and 1992 land productivity generally declined as reduced use of farm inputs due to their high cost after liberalization and a policy of input subsidy removal was implemented The government objective of increased productivity in cereal production for food self sufficiency and food security therefore suffered a setback under this policy Thus if the government continues to pursue productivity increases for cereal farmers as a policy objective, it will be necessary to introduce some type of selective subsidy that is both input and crop specific This could be given as credit in the form of inputs (as part of a technological package) to farmers The implementation could be done by a private financial institution with a government guarantee for the interest on the credit and the levels of subsidies involved

In terms of financial returns, the effect of exchange-rate liberalization and input-subsidy removal on cereals in Ghana has been mixed The high production cost and the subsequent decrease in productivity on cereal worsened the financial returns per hectare to maize and rice farmers For example on the average maize farmers (except those using traditional technologies) received negative financial returns per hectare in 1992 On the other hand financial returns per hectare for sorghum and millet farmers increased between 1986 and 1992 This was due more to increases in output prices than to productivity increases

The liberalization policy has resulted in the erosion of protection enjoyed by cereals produced in Ghana A 54% nominal protection enjoyed by rice in 1988 declined to 20% in 1992 and maize, which enjoyed a 10% nominal protection in 1988 was taxed implicitly at the rate of 1% in 1992 The nominal protection for sorghum and millet also declined from more than 40% in 1988 to only 4% in 1992 Moreover, high input costs mean that all cereals except rice moved from positive effective protection (about 33% for mechanized maize and more than 70% for improved sorghum and millet) in 1988 to taxation by 1992 (35% implicit tax on maize and 6% on sorghum and millet) The impli-

cation is that the economic environment under the liberalization policy did not favor cereal production because it resulted in a resource squeeze on the subsector, particularly for maize, which has potential for export Considering the importance of maize to Ghana s food economy (maize is the major staple cereal), it will be appropriate to put in place a program that targets and promotes maize production (along with the other cereals)

The effect of liberalization and input-subsidy removal on cereals has been mixed Whereas the competitiveness of sorghum and millet improved between 1988 and 1992 at the farmgate and wholesale levels (probably because they require fewer imported inputs), maize and rice showed deterioration in their competitiveness at the wholesale level during the same period A sensitivity analysis showed that yield increases for the cereals and lower transport cost in both the input and output markets can substantially improve their competitiveness Also, analysis of cereal price relatives indicates that tariffs (and other such policies) on rice, which is an importable cereal, adversely affect maize (an exportable cereal) and cause hikes in the prices of the nontradable cereals (sorghum and millet) on the domestic market Thus the imposition of excessive tariffs may not be the best policy because of its unintended side effects on other cereals A more pragmatic policy for cereals in Ghana should aim at productivity increases through crop-targeted programs

Literature Cited

Agriculture in Ghana Facts and figures 1991 Accra Presbyterian Press

Asante E O S Asuming-Brempong and P A Bruce 1989 *Ghana Grain marketing study* Accra Ministry of Agriculture/World Bank

Asiedu Saforo K 1989 Economic reform programs and agricultural development Macro policy sequencing in Ghana (1983-88) *Food Policy* 14 359-70

Asuming-Brempong S 1989 Ghana rice policy The cost of self sufficiency *Africa Development* 14 (4) 67-82

Asuming-Brempong S and A K Asante 1991 Policy conflict and small farmer response The case of foodcrop farmers in Ghana Paper presented at the 11th Annual Symposium of the Association of Farming Systems and Research/Extension Michigan State University East Lansing

Asuming-Brempong S and J C Flinn 1990 Rice Self Sufficiency Rice Research Priorities in Ghana *Quarterly Journal of International Agriculture* 29(2) 173-91

Chand S K and K van Til 1988 Ghana Towards stabilization and recovery *Finance and Development* 25(1) 32-5

Dapaah S K 1989 Population and agriculture in Ghana Paper presented at the National Workshop on Population Resource Environment and Development in Ghana Accra Ghana

Dornbusch R 1974 Tariffs and nontraded goods *Journal of International Economics* 4 177-85

International Fertilizer Development Center 1991 Accra Mimeo

Ministry of Agriculture 1986 *Ghana agricultural policy Action plans and strategies (1986 1988)* Accra

Oyejide T A 1986 *Effects of trade and exchange rate policies on agriculture in Nigeria* Research Report No 55 Washington D C International Food Policy Research Institute

Salinger, L 1986 Agricultural policy and trade policy framework Report Prepared for the Agricultural Services Rehabilitation Project Ghana IBRD WAPAB Mimeo

Salinger L 1986 Users guide to the template for the calculation of profitability protection and comparative advantage indicators Somerville Massachusetts Mimeo

Scandizzo P L and C Bruce 1980 *Methodologies for measuring price intervention effects* World Bank Staff Working Paper No 394 Washington D C World Bank

Sjaastad, L A 1980 Commercial policy true tariffs and relative prices In *Current issues in commercial policy and diplomacy* ed J Black and B Hindley New York St Martin Press

Tshibaka, T B 1986 *The effects of trade and exchange rate policies on agriculture in Zaire* Research Report 56 Washington D C International Food Policy Research Institute

Determinants and Effectiveness of Government Expenditure Policy in Ghana's Agricultural Sector

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SUMMARY
In the last three decades, Ghana has been ruled by a series of regimes with varying political and economic agendas All have used public expenditure as a policy instrument to shore up growth in Ghana's agricultural sector, the backbone of the nation s economy Despite these efforts, aggregate agricultural productivity generally declined over the study period, 1960 to 1987, raising questions as to the history, determinants, and effectiveness of public agricultural expenditures in Ghana

Analysis of data over the study period shows that annual government agricultural expenditures have tended to be low in Ghana, averaging 1 50% of gross national product, 1 51% of gross domestic product, and 8% of total government expenditure In real terms, public expenditures on agriculture peaked in 1965 and then declined by nearly 80% by 1987

Since becoming a republic in 1960, Ghana's government has been largely dominated by military regimes, with civilian governments ruling from 1960 to 1966, 1969 to 1972, and 1979 to 1981 An examination of agricultural expenditures by government type shows that the average annual *real* government expenditures on agriculture have been 71% higher under civilian regimes Whereas it has grown by an average of 6 2% per year under civilian governments, it has declined by an average of 1 7% annually under military governments Although the average share of agriculture in total public expenditure has been nearly equivalent for the two types of government, a negative correlation is found between the shares of defense and agriculture in total government expenditures

The governments of Ghana have variously pursued either a socialist or a market-oriented approach to national economic development As expected, a comparison of government expenditures by economic orientation for the years 1960 to 1986 shows that the annual growth of real government expenditure on agriculture has been higher during socialist regimes than during market-oriented regimes, averaging 6 3% for the former and –6 0% for the latter Similarly, agriculture's share of total government expenditures has been slightly higher under socialist administrations One of the goals of the economic policy reforms introduced into Ghana in April 1983 under the IMF-World Bank-supported Structural Adjustment Program is to expand agriculture's share in total public expenditures to 18% The fact that agriculture's share in total government expenditures fell from 11 4% in 1983 to 6 0% in 1986, during a period when market-oriented policies were being implemented, further supports the hypothesis that market-oriented regimes tend to commit relatively fewer financial resources to agriculture

A policy reaction approach is taken to ascertain the determinants of government agricultural expenditures Standard economic causality tests were used to test which variables may have affected the level of public expenditures on agriculture It was found that gross domestic product from agriculture, per-capita agricultural income government tax revenue total government expenditures and the ratio of agricultural to nonagricultural income have exhibited a causal relationship with the level of public agricultural expenditures The growth of public agricultural expenditures was found to be linked to growth in eight variables including total agricultural output, per-capita agricultural income, the ratio of agricultural to nonagricultural income and total government tax revenue The share of agriculture in total government expenditures was also found to be linked to eight variables including total agricultural output per-capita agricultural income the ratio of agricultural to nonagricultural income and prices, the real world price of coffee and the type of economic management

These causality test results indicate that public agricultural expenditure levels are determined by public financial resource availability and the perceived need to accomplish the agricultural policy objectives of (1) increasing agricultural output (2) increasing the income of agricultural workers and (3) increasing agricultural incomes relative to incomes in the rest of the economy

A varying parameter agricultural-output function was used to estimate the effectiveness of real government expenditures in increasing aggregate agricultural output The elasticity of real agricultural output with respect to real public agricultural expenditures was calculated from the regression results It was found that the average policy-effectiveness elasticity for the period 1965 to 1987 was –0 2973, implying that a 10% increase in the weighted variable representing agricultural spending has corresponded with an average decrease of 2 97% in total agricultural output The effectiveness of agricultural expenditure policy appears to have varied over the study period, being least ineffective in the 1980s and most ineffective in the 1970s

The study results clearly show that the type of government and the type of economic management have made a difference in the level and rate of growth of financial resources devoted to agriculture The implication is that to release public financial resources for agricultural development there is need to reduce public defense expenditures and to encourage the democratic election of civilian administrations In addition any drive toward a market oriented economy should be tempered with careful control of public expenditures to keep agriculture from suffering further

The estimated policy effectiveness elasticities indicate that public agricultural expenditure policies have been generally ineffective in inducing increases in aggregate agricultural output during the period It is important therefore, to review public expenditure policy in general and government agricultural expenditure policy in particular, if public expenditure policy is to play a meaningful role in Ghana's agricultural development process

Since Ghana s independence in 1957 a series of governments of varying political and economic persuasions have used public expenditures as a policy instrument to stimulate growth in the agricultural sector The commitment to shoring up agricultural productivity with public expenditures has varied over time and by administration In general the results have been disappointing The agricultural sector, which provides over half of the nation s employment and the largest share of the nation s gross domestic product, has been characterized by declining productivity over the study period, 1960 to 1987 This raises the questions

- What has been Ghana s history of public expenditures on agriculture?
- What key factors have determined the amount of public expenditures on Ghana s agricultural sector? Has the type of government—civilian versus military, socialist versus market-ori-

Table 1 Description of successive government administrations in Ghana, 1960 to 1987

Period	Administration	Type of government	Economic management
1960 66	Convention People s Party (Nkrumah)	Civilian	socialist
1966 69	National Liberation Council (Ankrah/Afrifa)	Military	market oriented
1969 72	Progress Party (Busia)	Civilian	market oriented
1972 78	National Redemption Council (Acheampong)	Military	socialist
1978 79	(Akuffo)	Military	socialist
June Sept 1979	(Rawlings)	Military	socialist
1979 81	People s National Party (Limann)	Civilian	market oriented
1981 83	Provisional National Defense Council (Rawlings)	Military	socialist
1983 87	PNDC (Rawlings)	Military	market oriented

ented—affected the share of annual budgets allocated to agriculture?

- What measurable effect have government expenditures had on Ghana s total agricultural output?

Despite the relevance of these questions to the effective management of agricultural growth in Ghana, these subjects suffer from a dearth of studies and information As Elias (1981) observes, existing studies of public expenditure policy tend to focus on the macro-economy rather than the agricultural sector, or they are confined to examining the effectiveness of specific public programs such as agricultural research or the development of irrigation systems Moreover no empirically tested, theoretical model of the determinants of agricultural expenditure policy is apparent in the agricultural economics literature Schuh (1981) and Rausser (1982) observe that the determinants of agricultural policy decisions are largely unknown Although general procedures for treating government expenditures as an endogenous variable exist (Heidhues 1976, Lattimore and Schuh 1979, Rausser, Lichtenberg, and Lattimore 1982, Rausser 1982 Fosu 1986, Fosu 1987, and Theil 1964), most empirical studies treat public agricultural expenditures as an exogenous variable An attempt by Elias (1985) to estimate the determinants of government agricultural expenditures empirically was largely thwarted by collinearity problems inherent in his model and his failure to provide any theoretical underpinning for the arguments used in his regression equations

Most research relating to the economic policies affecting agriculture has centered on normative or prescriptive issues rather than on positive analysis While the relevance of examining normative issues is indisputable, positive analyses must also be performed if the determinants and effectiveness of agricultural expenditures are to be understood and future expenditure policy trends are to be predicted This study attempts to narrow this gap in knowledge by examining the history and estimating the key determinants and measurable output effects of Ghana s agricultural expenditure policy from 1960 to 1987

Pattern of Government Expenditures on Agriculture

Composition of agricultural expenditures

Successive Ghanaian governments (table 1) have expended various amounts of public funds to stimulate the nation's agricultural development Interviews with personnel from the ministries of agriculture, finance, and economic planning and from the Accountant General s Department reveal a lengthy list of agricultural expenditure items

All post-independence governments have financed the administration of the ministries and public corporations accorded a stake in the management of Ghana's agricultural sector Public monies have been devoted to improved seed multiplication, plant disease and pest control, irrigation, land reclamation and drainage, land planning and soil conservation, fertilizer import and distribution, and the maintenance of a farm supplies unit To encourage livestock production, governments have financed animal husbandry improvement programs, veterinary services, rabbit projects, poultry hatcheries, and the acquisition of artificial insemination materials Governments have also imported, distributed, and subsidized farm implements

and mechanical equipment Farmers use of tractor-hire services has been subsidized particularly dur ing the Nkrumah and Busia regimes Farm labor use has been subsidized particularly on cocoa farms during the Busia regime The Nkrumah re gime established state crop farms and initiated farm settlement schemes in part to take advantage of the hydroelectric power generated after construction of the Volta Dam The Nkrumah regime also allocated funds for the establishment and maintenance of a Farm Workers Brigade and the United Ghana Farmers Cooperative Council Governments have financed agricultural research and extension activi ties and the dissemination of agricultural informa-tion via publications radio and television Rural infrastructure such as electricity potable water supply agricultural storage facilities health and other social services and feeder roads to farming communities have also been financed or subsidized by public monies Finally, governments have expended public funds to support farm product prices subsidize farm credit and provide cheap food to urban dwellers The relative importance of each of these expenditure items could not be determined due to lack of accessible data

Agricultural expenditure levels 1960-87

Time-series data on nominal government agri cultural expenditures in Ghana shows a dramatic escalation from 1960 to 1987 This reflects the rapid inflation in the cedi rather than real improve ment in the levels of government resources devoted to agriculture When nominal time-series data is deflated by the national consumer price index it is

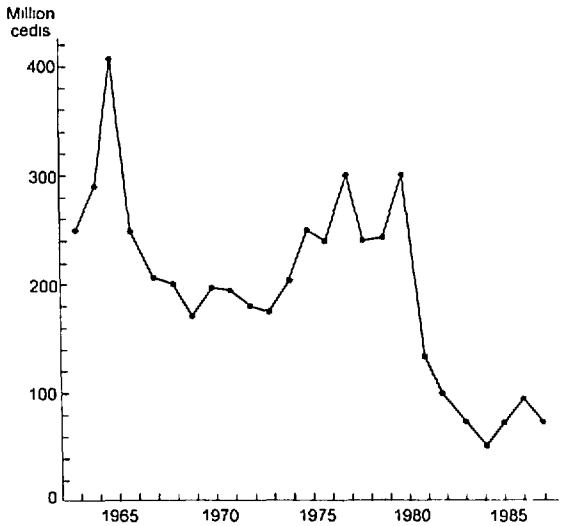

Fig 1 Real government expenditures on agriculture 1963-87

Source Ghana Statistical Service and Account General s Department Figures deflated by national consumer price index

obvious that real government spending on agricul ture peaked in 1965 and has declined by roughly 80% since then Upsurges in real government spending in the first half of the 1960s and again in the 1970s were overshadowed by sharp declines in real government spending from 1966 through 1969 and from 1981 through 1984 (fig 1)

Data on annual public expenditures on agriculture relative to other economic measures also indicate low and generally declining levels of government assistance to agriculture For example government agricultural expenditures relative to GNP averaged 1 69% 1 57% and 1 19% for the 1960s 1970s and 1980s respectively Similar declines in agricultural assistance are evident when government agricultural expenditures are compared

Table 2 Mean annual government expenditures on agriculture relative to GNP GDP, agricultural GDP agricultural land area, and labor employed in agriculture, various periods 1960-87

Variable[a]	1960s	1970s	1980 87	1960 87
Real agr expenditures (₵ millions)	254 13	223 41	117 47	138 20
Agr expenditures / GNP (%)	1 69	1 57	1 19	1 50
Agr expenditures / GDP (%)	1 66	1 62	1 17	1 51
Agr expenditures / GDP A[b] (%)	4 38	2 96	2 15	2 99
Real agr expenditures / ha[c] (₵)	96 03	83 38	42 23	75 07
Real agr expenditures / agr labor unit (₵)	133 15	109 71	48 06	96 55

Source Ghana Statistical Service Accountant General s Department FAO

[a]Real figures obtained by deflating nominal figures by the national consumer price index using constant 1977 prices

[b]Agricultural GDP Data not available for 1960 64 means exclude these years

[c]Due to data limitations 1960 64 and 1987 are excluded

with available data on gross domestic product and gross domestic product from agriculture, and when real public agricultural expenditures are examined per hectare of agricultural land and per unit of labor employed in agriculture (table 2)

The share of agricultural spending in total annual government expenditures has averaged about 8% over the study period, with a standard deviation of 2 99 A high of over 17% was reached in 1980 under the civilian regime of Hilla Limann (People s National Party) compared with a low of about 5% achieved in 1987 under the military leadership of the Provisional National Defense Council With the exception of the peak years 1979 and 1980, government expenditures on agriculture have ranged between approximately 5% and 10% of total government spending (fig 2)

Agricultural expenditures Military versus civilian regimes

Since independence military regimes have directed Ghanaian government over the periods 1966 to 1969 1972 to 1979 and 1981 to the present (1991) Military coups occurred in 1966, 1972, 1978 1979 and 1981 Civilian regimes existed under Nkrumah (Convention People's Party) from 1960 to 1966, Busia (Progress Party) from 1969 to 1972 and Limann (People's National Party) from 1979 to 1981 (table 1) It would be reasonable to expect that military regimes would place a greater emphasis on military expenditures than would elected civilian governments, particularly just following a coup Given a fixed budget amount any increase in military expenditures would reduce the budget share available to other sectors of the economy, such as agriculture

An examination of agricultural expenditures by type of government shows that the average annual real government expenditures on agriculture have been 71% higher under civilian regimes than under military regimes Similarly, real government expenditures on agriculture have grown by an average of 6 2% per year under civilian regimes, while declining by 1 7% per year under military regimes In both cases, the coefficient of variation is higher for the military regime averages, indicating a greater degree of relative dispersion and uncertainty in the annual budget amounts dedicated to agriculture under military regimes than under civilian regimes (table 3)

Because total government expenditures have also tended to be higher under civilian regimes the average annual share of agricultural expenditures relative to total government expenditures is nearly equivalent for the two government types A *t*-test shows no significant difference between the two means at the 5% level of significance (table 3) The trade-off between government spending on agriculture and defense is more apparent when the correlation between defense shares and agriculture shares of total government spending are examined by government type The product moment correlation coefficient is –0 64 for civilian regimes and -0 53 for military regimes, indicating an inverse relationship between military and agricultural shares

Table 3 Mean real government expenditures on agriculture growth, and share of total government expenditures, by type of government, 1960 to 1986[a]

Type of government	Annual agr expend (₵ millions)	Growth of annual agr expend (%)	Agr share or total annual expend (%)
Civilian	252 9	6 2	8 66
	(0 33)	(4 9)	(0 36)
Military	180 3	–1 7	8 15
	(0 41)	(13 2)	(0 35)

Source Derived from data obtained from the Ghana Statistical Service and the Accountant General s Department

[a]Coefficients of variation (in parentheses) indicate the ratio of the standard deviation to the reported mean Real figures were obtained by deflating nominal figures by the national consumer price index using constant 1977 prices

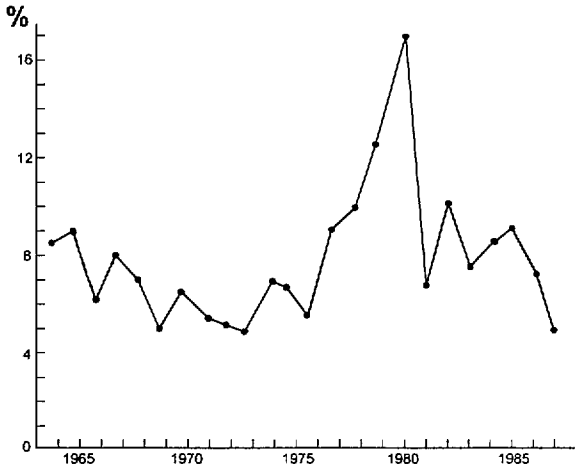

Fig 2 Annual share of agriculture in total government expenditures, 1963 to 1987

Source Derived from figures obtained from the Ghana Statistical Service and the Accountant General s Department

Table 4 Correlation between the share of agriculture and the share of defense in annual government expenditures by government type and period 1960 to 1986

Parameter	Civilian government	Military government	1960s	1970s	1980 86	1960 86
Product moment correlation coefficient[a]	–0 64 (–2 3559)	–0 53 (–2 4206)	–0 75 (–3 2071)	–0 84 (–4 3788)	–0 21 (–0 4803)	–0 51 (–2 2963)
Degrees of freedom	8	15	8	8	5	15

Source Derived from data obtained from the Ghana Statistical Service and the Accountant General s Department
Note All correlation coefficients are statistically significant at the 5% level except for the1980 86 period
[a] Figures in parentheses are *t* values

of total government spending This inverse relation ship between military and agricultural spending is also apparent when expenditure shares are compared by decade (table 4)

Agricultural expenditures by economic orientation

The post independence governments of Ghana have variously pursued either a socialist or a m ir ket-oriented approach to nation il economic devel opment The former mode accords a greater role in the economic development process to the public sector whereas market-oriented governments tend to rely more heavily on the private sector to stimulate economic growth It follows that the growth rate of real public expenditures on agriculture would be higher under a socialist regime than under a market-oriented regime

For the purposes of this study the period 1960 to 1965 under the Convention People s Party is considered to be dominated by the socialist mode of economic management The periods 1966 to 1968 under the National Liberation Council and 1969 to 1971, under the Progress Party saw Ghana adopting market-oriented policies and according a greater role to the private sector as compared with the public sector The National Redemption Council (NRC) which gained control of the gov ernment in January 1972 switched Ghana back to the socialist mode of economic management Although the NRC did undergo some metamorphoses into Supreme Military Council I and Supreme Military Council II there was general adherence to socialist economic policies from 1972 to 1979 The government of the People s National Party which ruled Ghana from 1980 to 1981 employed market oriented policies Ghana was again switched back to socialist policies by the Provisional National Defense Council (PNDC) in 1982 However, the need to procure financ il resources from multilat eral financial institutions such as the International Monetary Fund stimulated the PNDC to revert to market-oriented policies from April 1983 to date (table 1)

As expected a comparison of government expenditures by economic orientation for the years 1960 to 1986 shows that the average annual growth r ite of real government expenditures on agriculture has been higher during socialist administrations than during market oriented ones Indeed re il government expenditure on agriculture grew by an average of 6 3% per year under socialist regimes and fell by 6 0% per year under market oriented regimes (table 5) Agricultur s share of total government expenditures has been slightly higher under soci list administrations 8 5%, compared with 8 2% under market-oriented regimes

Interestingly one of the goals of the economic policy reforms introduced in Ghana in April 1983 under the IMF/World Bank-supported Structural Adjustment Program has been to increase the share of agriculture in total public expenditures to 18% (World Bank 1986) As shown in table 6, this goal has not been met Instead, agricultur s share of total government expenditures declined by an average of 16 1% per year between 1983 and 1986, falling from 11 39% of total government expenditures in 1983 to 6 05% of total government expenditures in 1986 The fact that these declines in the agricultural share of total government expenditures occurred during a period when market-oriented policies were being implemented by the PNDC government supports the hypothesis that market oriented regimes tend to commit relatively less financial resources to agriculture than do socialist regimes

Table 5 Mean real government expenditures on agriculture, growth and share of total government expenditures by type of economic management, 1960 to 1986[a]

Type of economic management	Growth of annual agr expenditures (%)	Share of total annual expenditures (%)
Market oriented	−6 0	8 2
	(−4 7)[a]	(0 40)
Socialist	6 3	8 5
	(2 98)	(0 32)

Source Derived from data obtained from the Ghana Statistical Service and the Accountant General s Department

[a]Coefficients of variation (in parentheses) indicate the ratio of the standard deviation to the reported mean Real figures were obtained by deflating nominal figures by the national consumer price index using constant 1977 prices

Determinants of Government Expenditures on Agriculture

Various objectives have been pursued with the financial resources Ghanaian governments have committed to agriculture Among these the key objective has been increasing domestic agricultural output Other objectives have included stabilizing or increasing real farm income, increasing the income of farm labor providing food subsidies to consumers, and equalizing income distribution between agriculture and the rest of the economy The ability of governments to accomplish these objectives through the outlay of public financial resources is constrained by both domestic and foreign economic factors as well as political factors Therefore, economic and political forces coupled with the combination of policy objectives to be achieved are likely to be the determinants of public expenditures on agriculture

A government s choice of, and financial commitment to specific agricultural policy objectives are expected to be a function of the difference between existing and desired levels of relevant policy variable indicators For example, a higher level of financial commitment to agricultural output growth is expected to occur when recent output growth rates have been far below desired levels Similarly, a substantial increase in the consumer price index could stimulate government to increase food subsidies to consumers, since food prices are a significant factor in the consumer price index

Table 6 Annual share of agriculture in total government expenditures and annual growth rate of agricultural share of total government expenditures 1983 to 1986

Period	Share of agriculture (% / yr)	Growth of agricultural share (% / yr)
1983	11 39	
1984	6 34	−44 3
1985	5 69	−10 2
1986	6 05	6 3
1983 1986 (mean)	7 37	−16 1

Source Derived from data obtained from the Ghana Statistical Service and the Accountant General s Department

Use of this policy reaction approach to ascertain the determinants of government agricultural expenditures yields a large number of variables that could influence public agricultural spending levels (See Fosu 1989 for a formal theory of the endogenization of government agricultural expenditure policy) Incorporation of all possible variables would result in multicollinearity problems and a tremendous loss of degrees of freedom in any given regression equation Therefore, only a subset of the potential determinants of public expenditures on agriculture is considered

Causality tests

Standard economic causality tests described by Granger (1969, 1980) can be used to determine which variables may have affected the level of government spending on agriculture According to Granger's notion of causality, in order for a variable $\mathbf{W}(t)$ to cause another variable $\mathbf{Z}(t)$ $\mathbf{W}(t)$ must encompass some unique information concerning what value $\mathbf{Z}(t)$ will take in the future Therefore, given any two vectors of stochastic variables $\mathbf{W}(t)$ and $\mathbf{Z}(t)$ that are jointly covariance stationary if the past values of $\mathbf{W}$ provide additional information for the prediction of $\mathbf{Z}$, then $\mathbf{W}(t)$ is said to *cause* $\mathbf{Z}(t)$ in the Granger sense If the minimum predictive error variance of $\mathbf{Z}(t)$, given the past values of $\mathbf{Z}$ and the current and past values of $\mathbf{W}$, is less than the minimum predictive error variance of $\mathbf{Z}(t)$, given the past values of $\mathbf{Z}$, then $\mathbf{W}(t)$ is said to *instantaneously cause* $\mathbf{Z}(t)$ in the Granger sense

To examine whether potential determinants of public agricultural expenditures cause public agricultural spending in Ghana, the following ordinary least squares regression equations are run for each jth determinant

$$G_A(t) = d_{oj} + \sum_{i=1}^{M} d_{ij} G_A(t-i) + u_{3j}(t)$$

$$G_1(t) = c_j + \sum_{i=1}^{M} c_{ij} G_1(t-i) + \sum_{i=1}^{N} f_{ij} W_j(t-i) + u_{3j}(t)$$

where G_1 is public agricultural expenditures and u and u_3 denote stochastic error terms that satisfy the normal classical regression assumptions

From the respective sum of squares of the error terms, SSE(1) and SSE(2) a statistic F_j can be computed for a given sample size S as follows

$$F_j = \frac{\text{SSE(1)} - \text{SSE(2)}}{\text{SSE(1)}} \times \frac{(S - M - N - 1)}{N}$$

where in the present study, $M - N - 1$ is employed

Statistically F_j exhibits an F-distribution with degrees of freedom equal to N, $(S - M - N - 1)$ The decision criterion for ascertaining causality reduces to the following If F_j is greater than the tabulated F for N $(S - M - N - 1)$ degrees of freedom at a specified level of significance then the null hypothesis that the potential determinant W_j does not cause the level of public agricultural expenditure is rejected in favor of the alternative hypothesis that W_j does cause public agricultural expenditure If causality runs from W_j to G_1 then public agricultural expenditure is endogenous with respect to W_j Similarly if causality is not found between the variables then government agricultural expenditure is exogenous with respect to W_j

To examine the issue of instantaneous causality the following regression equation is added

$$G_A(t) = g_j + \sum_{i=1}^{M} g_{ij} G_A(t-i) + \sum_{i=0}^{N} h_{ij} W_j(t-i) + u_{4j}(t)$$

where u_4 denotes a stochastic error term that satisfies the normal classical regression assumptions F is then computed by deriving the sum of squares of the errors of this equation SSE(3) and inserting it into the following F-statistic

$$F_{i2} = \frac{\text{SSE(1)} - \text{SSE(3)}}{\text{SSE(1)}} \times \frac{(S - M - N - 2)}{(N + 1)}$$

Using degrees of freedom equal to $(N+1)$ $(S - M - N - 2)$ the decision criterion is as follows If F_2 is greater than the tabulated F for $(N + 1)$ $(S - M - N - 2)$ degrees of freedom at a specified level of statistical significance then the null hypothesis that W_j does not instantaneously cause public agricultural expenditure is rejected in favor of the alternative hypothesis that W_j does instantaneously cause public agricultural expenditure in the Granger sense

Although other approaches to causality testing have been formulated (Suppes 1970 Sims 1972 Pierce and Haugh 1975 Fiege and Pearce 1978 Bessler Barnett and Thompson 1981 Geweke 1982 and Geweke Meese and Dent 1982) the Granger definition of causality is used in the present study because it is an operational one and gives rise to a simple empirical test The usefulness of causality tests for policy evaluation is discussed by Granger (1988), who also presents some related recent developments

Causality test results Agricultural expenditure levels

The following variables were tested to determine whether they caused the level of real public agricultural expenditure in the Granger sense

Q_1 = real gross domestic product originating in the agricultural sector
P = national consumer price index
P_f = food component of national consumer price index
UP = urban consumer price index
UP_f = food component of urban consumer price index
P = world agricultural export price index
P = real foreign price of cocoa
P_f = real foreign price of coffee
Y_1/Y_3 = ratio of annual income of private farm labor and annual income of private manufacturing labor
Y_1/L_1 = agricultural net value added per unit of agricultural labor
T = real total tax revenue
C = real net domestic credit to government
C_1 = real aggregate agricultural credit
FR = total foreign reserves
G = real total government expenditure
G_d = real total government expenditure on defense
V_t = type of government (military = 1 civilian = 0)
V = type of economic management (socialist = 1 market oriented = 0)

All causality tests were performed at the 5% level of statistical significance and Durbin s h statistic was used to test for first-order autocorrelation The variables that were found to cause the

Table 7 Determinants of the level of real annual public expenditures on agriculture in Ghana Causality test results for $M - N - 1$

Variable[a]	R^2	F_{c1}	Degrees of freedom	Durbin s h[b]	Existence of causality[c]	Period covered
Q_A	7205	11 5567	1 20	–0 7628	yes	1965 87
Y_A/L_A	6529	7 1861	1 13	NC	yes	1970 85
T	6943	6 7911	1 22	–1 2868	yes	1963 87
G	6696	5 3096	1 21	–0 8670	yes	1964-87
C	5385	0 8744	1 20	0 0000	no	1963 85
P	5551	3 1665	1 21	NC	no	1963 87
P_f	6187	3 0289	1 22	NC	no	1963 87
UP	5560	3 0994	1 21	4 5736	no	1963 87
UP_f	6170	2 9429	1 22	NC	no	1963 87
P_w	6135	2 6430	1 21	–0 1211	no	1963 86
P_{coc}	5596	0 0854	1 32	–0 2330	no	1963 86
P_{cof}	5322	0 6108	1 20	–0 1195	no	1963 85
Y_A/Y_N	7537	9 1100	1 14	–1 6692	no	1970 86
FR	5591	0 0644	1 22	–0 1574	no	1963 87
V_1	5661	0 4358	1 22	–0 1936	no	1963 87
V_2	6191	3 0471	1 22	–0 7102	no	1963 87
C_A	5785	1 0270	1 22	–1 0235	no	1963 87
G_m	5883	1 4448	1 21	–0 4785	no	1963 86

Source Causality test results derived from data obtained from the Ghana Statistical Service IMF FAO United Nations Bank of Ghana and Gill and Duffus Group (1981) for 1960 to 1987

Notes The unrestricted regression is corrected for serial correlation All the R^2 figures are for the unrestricted regression P_w is used as the deflator for foreign cocoa and coffee prices All other real variables were computed using the national consumer price index as a deflator

[a]Defined in the text

[b]NC = noncomputable

[c]Causality tests conducted at the 5% level of significance

level of real public agricultural expenditure in the Granger sense with a 1-year lag are real gross domestic product originating in the agricultural sector (Q_A), income per unit of labor employed in the agricultural sector (Y_A/L_A) real total government tax revenue (T), and real total government expenditure (G) (table 7)

The variables that were found to instantaneously cause real public agricultural expenditure in the Granger sense are the four variables listed above in addition to the agricultural-nonagricultural income ratio (Y_A/Y_N)

These results indicate that the levels of real public agricultural spending have been largely determined by the perceived need to achieve agricultural policy targets relating to aggregate agricultural output, income per unit of agricultural labor, and the income differential between agricultural and nonagricultural workers The level of public financial resources, as indicated by real government tax revenue and real total government expenditure, is also indicated as playing a determining role in the level of real public agricultural spending

Causality test results Growth of agricultural expenditures

All of the variables subjected to causality tests above, with the exception of the dummy variables V_1 and V_2, were also tested to determine whether their growth rates caused the growth rates in real public agricultural expenditures, using a 1-year lag Three additional ratios were also examined for this purpose the agricultural-nonagricultural price ratio (P_A/P_N), the share of agriculture in gross domestic product (Q_A/Q_T), and agriculture's share of the total labor force (L_A/L_T)

It was found that the growth of real public agricultural expenditures has been caused, in the Granger sense, by growth in the following variables (1) total agricultural output, (2) income per unit of agricultural labor, (3) total government tax revenue, (4) aggregate domestic net credit to government, (5) world agricultural export commodity price, (6) agricultural-nonagricultural income differential, (7) share of agriculture in gross domestic product, and (8) the share of agriculture in the total labor force (table 8)

Table 8 Determinants of the growth of real annual public agricultural expenditures in Ghana Causality tests for $M - N - 1$

Variable[a]	n[b]	R^2	F_{c1}	Durbin s *h*	Degrees of freedom	Existence of causality
Q_A	21	6248	8 6670	–0 4737	1 19	yes
Y_A/L_A	14	6173	6 0968	–0 2907	1 12	yes
T	23	6925	6 5828	–0 4233	1 21	yes
G	22	5674	1 5283	–0 6852	1 20	no
C	22	6296	5 4913	0 0829	1 20	yes
P	23	5756	1 9733	–0 3027	1 21	no
P_f	23	5672	1 5971	–0 2657	1 21	no
UP	23	5708	1 7555	–0 2091	1 21	no
UP_f	23	5614	1 3349	–0 1869	1 21	no
P_w	22	6529	9 9377	–0 6719	1 20	yes
P_{coc}	23	5824	1 1642	–0 3224	1 21	no
P_{cof}	21	5786	2 4088	0 0173	1 19	no
Y_A/Y_N	15	5899	6 4921	–0 6300	1 13	yes
FR	23	5625	0 2230	–0 5777	1 21	no
V_1	23	6156	2 7432	–0 1948	1 21	no
V_2	23	5953	1 7795	0 2514	1 21	no
G_m	22	5795	2 0455	0 4967	1 20	no
C_A	23	5630	1 4090	0 2076	1 21	no
P_A/P_N	23	5683	0 4955	0 2013	1 21	no
Q_A/Q_T	21	6243	8 6534	–0 3304	1 19	yes
L_A/L_T	21	6255	8 6852	–0 3254	1 19	yes

Source See table 7 Notes See table 7

[a]Symbols are defined in the text Causality tests are based upon the annual growth rate in these variables (except for V_1 and V_2) as compared with the annual growth rate of real public agricultural expenditures

[b]Sample size

Instantaneous causality is observed for three variables growth in aggregate agricultural output growth in the share of agriculture in gross domestic product and growth in the share of agriculture in the total labor force

These results support the hypotheses that policy objectives related to growth in agricultural output per capita agricultural income agricultural export price agricultural nonagricultural income differential agriculture s share of gross domestic product and agriculture s share of the total labor force determine the growth in real public agricultural expenditures along with financial resource constraints represented by government tax revenue growth and growth in domestic net credit to government

Causality test results Agriculture's share of total expenditures

All of the variables tested above for a causal relationship with growth in real agricultural expenditures were also tested to determine whether they caused the annual share of agriculture in total public expenditures The empirical results suggest that the agricultural policy targets that cause in the Granger sense agriculture s share of total government spending to be high or low are (1) total agricultural output (2) per-capita agricultural income and (3) agricultural nonagricultural income differentials In addition the type of economic management and real domestic net credit to government were found to be determinants of agriculture s share of total government expenditures (table 9) Instantaneous causality is suggested for three variables real world price of coffee agricultural-non agricultural price differentials and agriculture s share of gross domestic product

Effectiveness of Agricultural Expenditure Policy

Agricultural policy in Ghana has been largely devoted to increasing agricultural output Whether public agricultural expenditures have in fact resulted in higher levels of agricultural output is, therefore, a matter of some interest

According to Tinbergen (1970) an economic policy instrument is effective in stimulating a target variable if the change in the value of the target variable relative to the change in the value of the policy instrument is greater than zero that is if $\partial T/\partial I > 0$ where ∂ denotes a partial derivative and T and I denote the respective levels of the target variable and the policy instrument Tinbergen refers to this ratio as the effectiveness coefficient of the policy instrument

Applying this approach to the policy instrument, real public agricultural expenditure (G_{At}), and the target variable aggregate agricultural output (Q_{At}), if $\partial Q_{At}/\partial G_{At} > 0$ for the study period, then government agricultural expenditure has been effective in stimulating increased agricultural output The parameter $\partial Q_{At}/\partial G_{At}$ can be derived from an aggregate agricultural output function

The varying-parameter aggregate agricultural output function that was employed is specified as follows

$$\ln Q_{At} = a_0 + b_0 \ln \tilde{G}_{At} + (a_1 + b_1 \ln \tilde{G}_{At}) \ln A_t + (a_2 + b_2 \ln \tilde{G}_{At}) \ln L_t + (a_3 + b_3 \ln \tilde{G}_{At}) \ln K_t + b_4 \ln W_t + U_t$$

where

Q_{At} is aggregate agricultural output approximated by the real agricultural gross domestic product

$\tilde{G}_{At}$ is public input into agriculture measured as a weighted average of past real government agricultural expenditures

L_t is aggregate labor input into the domestic agricultural sector approximated by the economically active population in agriculture

A_t is the area under agricultural activities

K_t is capital input into agricultural production approximated by a measure of overall labor productivity in the economy

W_t denotes weather approximated by annual average rainfall in Ghana

U_t is a stochastic error term that satisfies the normal classical regression assumptions

The weights employed in the definition of $\tilde{G}_{At}$ are based on the rate of depreciation Assuming a depreciation rate of 5%, as suggested in the literature, and applying the conventional inventory approach for the measurement of stock of physical capital and stock of technology using geometrically declining weights the variable $\tilde{G}_{At}$ is given by

Table 9 Determinants of the annual share of agriculture in total government expenditures Causality tests for $M - N - 1$

Variable[a]	n[b]	R^2	F_{c1}	Durbin s h	Degrees of freedom	Existence of causality
Q_A	22	7406	5 0000	0 5212	1 20	yes
Y_A/L_A	15	7612	4 8750	0 6793	1 13	yes
T	24	6892	2 7500	0 9442	1 22	no
G	23	7109	2 6250	0 3350	1 21	no
C	22	7235	5 0000	0 2745	1 20	yes
P	24	6942	2 7500	1 0238	1 22	no
P_f	24	7087	2 7500	0 9795	1 22	no
UP	24	6924	2 7500	1 0256	1 22	no
UP_f	24	7094	2 7500	0 9847	1 22	no
P_w	23	6635	0 0000	1 8105	1 21	no
P_{coc}	23	6970	2 6250	0 6619	1 21	no
P_{cof}	22	7497	5 0000	–0 0987	1 20	no
Y_A/Y_N	16	7712	5 2500	0 0776	1 14	yes
FR	24	6668	0 0000	1 5367	1 22	no
V_1	24	6648	0 0000	1 4682	1 22	no
V_2	24	7261	5 5000	0 5083	1 22	yes
G_m	23	6635	0 0000	1 8380	1 21	no
C_A	24	6737	0 0000	0 6997	1 22	no
P_A/P_N	24	7049	2 7500	–0 2088	1 22	no
Q_N/Q_T	22	7144	2 5000	1 5591	1 20	no
L_A/L_T	22	7059	2 5000	1 9001	1 20	no

Source See table 7

Notes The unrestricted regression is corrected for serial correlation See table 7 for other notes

[a]Symbols are defined in the text

[b]Sample size

$$\tilde{G}_{t} = \sum_{i=0}^{t} 0.95^{i} G_{t-i}$$

where G_t denotes the volume of real government expenditures on agriculture

Government expenditures on agriculture affect various determinants of agricultural output For example spending on research and extension activities contributes to improvement in the quality of all factors of production Expenditures on fertilizers and irrigation contribute to the productivity of agricultural land Similarly expenditures on agricultural education and rural health contribute to the productivity of labor making it necessary to employ a varying parameter output equation

The ordinary least squares estimation technique was applied to the regression equation yielding the following estimation of parameters

$$\begin{aligned} Q_t = {} & 4.1764 + (-50.0256 + 8.4767\tilde{G}_{At})A_t \\ & (2.057) \quad (-2.579) \quad (2.532) \\ & + (13.9591 - 3.1168\tilde{G}_{At})L_t \\ & (1.505) \quad (1.643) \\ & + (5.5065 - 0.7977\tilde{G}_{At})K_t + 0.0857 \text{ TREND} \\ & (3.478) \quad (2.927) \quad (4.064) \end{aligned}$$

$R^2 = 0.9230$ adjusted $R^2 = 0.8815$ $F = 22.2558$ D W = 2.2071

where the conventional t-ratios are in parentheses below the estimated values of the coefficients and the variables are in natural logarithms as defined above

This regression result indicates that the intercept term and the coefficients constituting the elasticities of agricultural output with respect to agricultural land and capital are statistically significant at the 5% level The value for the coefficient of determination (R^2) implies that 92.3% of the variation in real aggregate agricultural output is explained by the model The weather variable was excluded from the final regression equation because it produced poor statistical results

Based on the regression results the elasticity of real aggregate agricultural output with respect to public agricultural expenditures is given by

$$e_{Q(G_A)} = 8.4767 \ln A_t - 3.1168 \ln L_t - 0.7977 \ln K_t$$

It can be seen from this equation that the elasticity that approximates the degree of effectiveness of public agricultural expenditure policy varies with the levels of use of agricultural land, labor and capital formation Because these levels vary from year to year the degree of effectiveness of public agricultural expenditure policy can vary with time The higher the elasticity the greater the effectiveness of the expenditure policy Elasticities of zero or less indicate the policy was ineffective in increasing aggregate agricultural output

The computed policy-effectiveness elasticities for the decades of the 1960s 1970s and 1980s encompassing the years 1965 to 1987 indicate that public agricultural expenditure policy has been generally ineffective in inducing increased total agricultural output (table 10) The average policy-effectiveness elasticity for the period is –0.2973 This implies that a 10% increase in the weighted variable representing agricultural spending corresponds with an average decrease of 2.97% in aggregate agricultural output between 1965 and 1987 Based on the elasticity results it appears that agricultural expenditure policy was least ineffective in stimulating agricultural output in the 1980s and most ineffective in the 1970s

Policy effectiveness elasticities have not been negative for all years included in the study The calculated elasticity measure increased from –0.8519 in 1965 to 0.1052 in 1968 From there it fell to –0.8679 in 1970 rising to –0.7967 in 1971 Policy effectiveness fell to –0.8191 in 1972 rising to –0.2806 in 1973 and falling to –0.6496 in 1974 Between 1974 and 1984 the policy-effectiveness elasticity maintained an upward trend rising to a high of 0.2897 in 1984 The measure subsequently fell to –0.3356 in 1985, rose to –0.2325 in 1986 and fell to –0.3533 in 1987

Table 10 Effectiveness of public agricultural expenditures in inducing increased aggregate agricultural output in Ghana 1965 to 1987

Period	Policy effectiveness elasticity (mean)
1965 69	–0.3414
1970–79	–0.4789
1980 87	–0.0427
1965 87	–0.2973

Source Computed from regression results on the basis of data obtained and derived from various sources including the Ghana Statistical Service IMF FAO United Nations Bank of Ghana and Gill and Duffus Group (1981)

Conclusions

The pattern of government expenditures on agriculture in Ghana over the period 1960 to 1987 clearly shows that the type of government and the type of economic management have made a difference in the level of financial resources devoted to the agricultural sector Civilian governments have not only outspent military governments in the agricultural arena they have increased real public agricultural spending by an average of 6 2% per year during a period in which the overall rate of public agricultural spending has declined dramatically Further analysis shows the negative correlation between the share of agriculture and the share of defense in the nation s total public expenditures

The implication is that since military regimes are not democratic but are imposed on a people through coups d etat they tend to augment military expenditures in a bid to consolidate their rule The result is that the share of defense in public allocations rises often at the expense of allocations to agriculture In the same vein, under a generally restrictive public expenditure regime, the need to curtail aggregate government expenditures is likely to be met under a military regime by sharper cuts in agricultural spending

Therefore, to release public financial resources for agricultural development in Ghana, there is the need to curtail public defense expenditures, including military expenditures on new machinery and equipment This, in turn, suggests that the size of Ghana's military be drastically reduced and that democratically elected civilian regimes be encouraged in lieu of military regimes

Similarly, the historical record shows that socialist regimes are associated with an increase in average real agricultural spending of 6 3% per year, whereas market-oriented regimes are associated with a decline in agricultural spending, averaging –6 0% per year Socialist regimes have also allocated a greater share of total government expenditures to agriculture and have shown a more consistent commitment to maintaining agriculture's share of government spending

Given that the current level of public expenditures on agriculture is inadequate, these results suggest that any drive toward a market-oriented economy should be tempered with careful control of public expenditures to keep agriculture from suffering

Causality test results using the Granger method indicate that public agricultural expenditure levels are determined by public financial resource availability and the perceived need to accomplish the agricultural policy objectives of (1) increasing agricultural output, (2) increasing the income of agricultural workers and (3) increasing agricultural incomes relative to incomes in the rest of the economy

The estimated policy-effectiveness elasticities indicate that public agricultural expenditure policies have been generally ineffective in inducing increases in aggregate agricultural output during the period There is the need, therefore, to review public expenditure policy in general and government agricultural expenditure policy in particular if public expenditure policy is to play a meaningful role in Ghana s agricultural development process

Literature Cited

Bessler David A Richard C Barnett and R L Thompson 1981 Agricultural prices in the 1970s and the quantity theory of money Paper presented at the Annual Meeting of the American Agricul tural Economics Association Clemson South Carolina

Elias Victor J 1981 *Government expenditure on ag riculture in Latin America* Research Report no 23 Washington D C International Food Policy Research Institute

Elias Victor J 1985 *Government expenditure on ag riculture and agricultural growth in Latin Amer ica* Washington D C International Food Policy Research Institute

Fiege E L and D K Pearce 1978 *The causal rela tionship between money and income Some cave ats for time series analysis* Workshop Series Pa per 7809 Social Systems Research Institute Madison University of Wisconsin

Fosu, K Yerfi 1986 Public-private financing choice under uncertainty An ophelimity theoretic model for Ecowas agriculture Paper prepared for Fourth Biennial Conference of the West African Economic Association Lome Togo

Fosu K Yerfi 1987 Macroeconomic policy impact on the mode of financing agriculture Paper prepared for Fifth European Congress of Agricultural Economists, Balatonszeplak Hungary

Fosu K Yerfi 1989 *A theory of public agricultural expenditure policy* Working Paper 89/1 Depart

ment of Agricultural Economics Legon University of Ghana

Geweke J 1982 Measurements of linear dependence and feed back between multiple time series *Journal of American Statistical Association* 77(378) 304 14

Geweke J R Meese and W Dent 1982 *Comparing alternative tests of causality in temporal systems Analytical results and experimental evidence* Workshop Series Paper 8212 Social Systems Research Institute Madison University of Wisconsin

Gill and Duffus Group 1981 *Cocoa statistics* London

Granger C W J 1969 Investigating causal relations by econometric models and cross spectral methods *Econometrica* 37 424 38

Granger C W J 1980 Testing for causality A personal viewpoint *Journal of Economic Dynamics and Control* 2 329 52

Granger C W J 1988 Some recent developments in a concept of causality *Journal of Econometrics* 39 199 211

Heidhues F 1976 National policy decisions as an adaptive process *European Review of Agricultural Economics* 3 349 89

Littmore R G and G F Schuh 1979 Endogenous policy determination The case of the Brazilian beef sector *Canadian Journal of Agricultural Economics* 27 1 16

Pierce D A and L D Haugh 1975 *The assessment and detection of causality in temporal systems* Technical Report 83 Department of Statistics Gainesville Florida University of Florida

Rausser G C 1982 Political economic markets PERTS and PESTS in food and agriculture *American Journal of Agricultural Economics* 64 821 33

Rausser G C E Lichtenberg and R Lattimore 1981 Developments in theory and empirical application of endogenous government behavior In *New directions of econometric modelling and forecasting in U S agriculture* ed G C Rausser 547 614 New York Elsevier North Holland

Schuh G E 1981 Economics and international relations A conceptual framework *American Journal of Agricultural Economics* 63 767 78

Sims C A 1972 Money income and causality *American Economic Review* 62 540 52

Suppes P 1970 *A probabilistic theory of causality* Amsterdam North Holland

Theil H 1964 *Optimal decision rules for government and industry* Amsterdam North Holland

Tinbergen Jan 1970 *On the theory of economic policy* Amsterdam North Holland

World Bank 1986 *Financing adjustment with growth in sub Saharan Africa 1986 1990* Washington D C

Fertilizer Pricing and Distribution Policy in Ghana

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SUMMARY

To meet increasing demand for food resulting from rapid population growth, high rate of urbanization and moderate increases in per capita income, the government of Ghana has launched the Medium-Term Agricultural Development Programme (MTADP) The program was aimed at achieving at least 4% per annum growth in the agricultural sector But it is not possible to realize the objective of the MTADP without a technological transformation of Ghana s agriculture, which has traditionally been sustained through a system of shifting cultivation This system, whose success depended upon abundance of land, is no longer sustainable as a result of the increasing pressure on land due to high population growth, which has given rise to more intensive methods of cultivation

Because the level of consumption of fertilizer in Ghana is one of the lowest in the world the current cultivation practices are leading to the degradation of soils and reduction of productive capacity To save Ghana s agriculture, steps must be taken to increase the availability and consumption of fertilizer in the medium-term Ghana s strategy for increasing fertilizer availability and consumption has been to privatize the supply and distribution of the input However, at the same time, subsidies on fertilizer were removed which tended to dampen demand

Using data from primary and secondary sources, this study investigated some of the causes for the low level of utilization and low volume of private retailing of fertilizer in Ghana after instituting price and distribution reforms The major foodcrops to which farmers apply fertilizer are maize and rice However, survey results indicated that many farmers do not use fertilizer on their foodcrops Even among those who use fertilizer, many apply less than the recommended amounts The low level of use of fertilizer may be largely attributed to lack of knowledge on the efficacy and methods of application of the input and the high price of the input in the absence of credit

Despite attempts to improve the supply of fertilizer, many of the farmers who use the input still complain about difficulty in obtaining their supplies Although the participation of the private sector in fertilizer supply and distribution has resulted in the availability of new forms of fertilizer, especially high-yielding low analysis materials, the response of the private sector to the privatization scheme has generally been poor The low participation of the private sector in the fertilizer privatization scheme can be attributed to a number of reasons including declining primary demand due to increased prices, accumulation of large stocks in the warehouses of the Ministry of Agriculture, which has had a discouraging effect on speculators, the continued participation of public sector organizations in fertilizer retailing which has dampened the enthusiasm of many private retailers, the low margins instituted by the government, which made fertilizer retailing unattractive when compared with other alternatives, lack of training for retailers in handling the specialized product,

absence of credit to meet the large capital outlays needed to acquire a few tons of fertilizer, the initial pan territorial pricing policy(uniform throughout the country), which discouraged retailers from selling fertilizer in localities far from the warehouses

The existence of poor markets for cereals has tended to inhibit the development of private input marketing The failure of the cereals market to arrest seasonal fluctuations in price led to an interventionist policy by the government through the operation of a farm-gate price support scheme for maize The scheme failed to provide the requisite incentives to producers due to deficiencies in its operation The government could not act as the buyer of last resort as it was able to handle only about 6% of the market due to logistic and financial problems

The agricultural sector was no exception to the economic deterioration that Ghana experienced in the 1970s and early 1980s which resulted from misguided domestic policies sometimes exacerbated by external factors Output of food and cash crops declined 0 3% per annum between 1970 and 1980 and the index of agricultural production (1969 71 = 100) stood at 82 in 1980 Cereal production which exceeded domestic demand by 200 000 tons in 1971 73 registered a deficit of over 330 000 tons in 1981 83 Production of starchy staples fell from 7 9 million tons in 1974 to 4 1 million tons by 1981 Cocoa production which peaked at 560 000 tons in 1963/64 fell to just 156 000 tons in 1983/84

In 1983 the government launched the Economic Recovery Program (ERP) to reverse the decline in the economy The aim of the ERP was to provide incentives for increased production so that the economy could be put on a sustained growth path A modest annual growth of 2 8% was achieved for the agricultural sector during the 1984 90 period but that was insufficient to meet an rising demand resulting from rapidly expanding population high urbanization and moderate increases in the per capita income To address this state of unstable equilibrium Ghana s Medium-Term Agricultural Development Program (MTADP) aims to achieve at least 4% annual growth in the agricultural sector The objective of the MTADP cannot be accomplished without a technological transformation of Ghana s agriculture which for some time was sustained by traditional shifting cultivation The system allowed the soil to be rejuvenated by a fallow period after a period of cultivation However due to increased pressure on the land due to population increases the length of the fallow period has been significantly reduced and many farmers have adopted more intensive methods of cultivation without the use of chemical fertilizers or organic manures The result is degradation of soils and reduction of productive capacity

The consumption of fertilizer in Ghana is among the lowest in the world In 1988 Ghana used less than 5 kilograms of plant nutrients per hectare of arable land as compared with 6 4 kg/ha in Mali, 21 5 kg/ha in Malawi and a world average of 98 7 kg/ha (FAO 1989) In 1990, Ghana's total fertilizer use was about 11 600 nutrient tons This level of use replenished less than one seventh of the nutrients removed by crops

As a step toward increasing the use of fertilizer, the Government of Ghana re-organized the extension services and privatized the distribution of the input to make it more widely available However, at the same time as part of Ghana s Structural Adjustment Program the subsidies on fertilizer were removed over a 3 year period

Research Problem

The productivity of Ghanaian farmers has been low and has improved little during the last 20 years Through the Sasakawa Global 2000 Program and other programs, it has been demonstrated that when farmers use improved seed and fertilizer and follow recommended agronomic practices, the yield of maize can reach as much as five times the Ghana s present 1 t/ha average

Ghana has a relatively well-established agricultural research system Through the activities of the faculties of agriculture of the three universities and the seven agricultural research institutes under the Council for Scientific and Industrial Research, proven technology exists that could tremendously increase the productivity of farmers and the output of many farm products However, productivity is still low despite the revamping of the extension

services to better inform farmers about yield-increasing technology It is obvious that the major reason for the low productivity is the low levels of fertilizer application

To resolve the issue, certain basic questions have to be answered What are the major reasons for the low level of application of fertilizer? What are the causes for the low participation of the private sector in fertilizer distribution? What are the major input and output marketing problems faced by farmers that militate against the adoption of technology and improved practices?

Research Objectives and Approach

This study investigated causes of the low adoption of fertilizer in Ghana after price and distribution reforms were instituted Specifically, the objectives of the study were to

1 Review the efficiency of the privatization scheme for the supply and distribution of fertilizer and to identify the causes of the private sector's low participation in the retailing, wholesaling, and importation of fertilizer
2 Investigate the causes of the low level of utilization of fertilizer despite improved extension services
3 Determine whether problems associated with marketing of maize are disincentives for the use of fertilizer

Data for the study were obtained from primary and secondary sources Primary data collection comprised informal discussions with Ministry of Agriculture officials and surveys of farmers and traders in fertilizer and maize Both personal interviews and focus-group discussions were conducted to obtain primary information

The study was undertaken in the Nkoranza district in Brong-Ahafo Region Savelugu district in Northern Region, and Hohoe district in Volta Region Brong-Ahafo and Volta regions have the longest history of privatization of the fertilizer in the country because the pilot scheme took place there Northern Region was chosen because it is the largest producer of maize in Ghana, which happens to be one of the crops on which fertilizer is applied most

A total of 313 farmers were interviewed 103 in Nkoranza district, 82 in Savelugu district and 128 in Hohoe district A questionnaire was used to interview all the farmers on the supply and distribution of fertilizer and the demand problems for the input Maize marketing questions were also posed Focus groups of six to eight farmers were formed for discussions on fertilizer problems

Secondary data on the number of registrants active dealers, and the volume of fertilizer they have handled from 1989 to 1991 were obtained from the Crops Input Development Unit of the Ministry of Agriculture Results from other studies were also consulted and used in the analysis

Conceptual Framework

To increase production, the price mechanism is often manipulated to create incentives for adoption of productivity-enhancing technologies and area expansion Common interventionist policies are the imposition of input subsidies or the establishment of price-supports Ghana has used both schemes in its agricultural policy implementation with unsatisfactory results Currently both input subsidies and price-support schemes have been discontinued in Ghana

Subsidies and level of input use and product output

Panel A in figure 1 illustrates the relationship between price of input X and the quantity of X that will be utilized with a given technology and output market conditions With the withdrawal of subsidy $(P_1 - P_0)$ the quantity of X utilized drops from X_0 to X_1 In panel B the total physical product, or output as a result of the use of input X drops from Q, to Q_1 with the removal of the subsidy The economic region of production in panel B is Q_2 to Q_3, where the marginal productivity of X increases with an increase in the use of X If the original level of use of X was such that production was in the efficient region it is possible that the removal of subsidies could bring the level of production to the inefficient region (below Q_2) However removal of subsidies can eliminate excessive use of the input (beyond X_3) to the level that would bring production to the optimal region Therefore we can conclude that

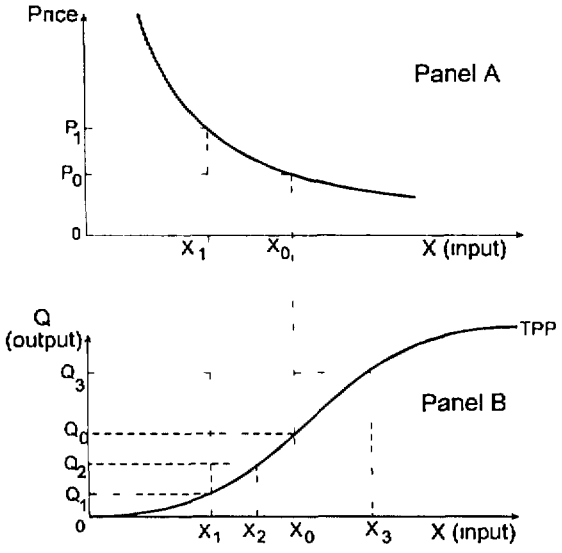

Fig 1 Impact of subsidies on level of input use and product output

when the level of use of the input is above X_3 withdrawal of subsidy (or an increase in price) would be desirable whereas when the level of use is below X_2 a fall in price or a subsidy would be needed to boost use of the input to ensure efficiency, *ceteris paribus*

The debate on the merits of input subsidies goes beyond technical efficiency Subsidies have tended to breed social vices and have even promoted misallocation of resources When the subsidized commodity is distributed by a central agency, it tends to lead to nepotism and corruption any time there is scarcity of the input When price differentials exist between the subsidizing country and a neighboring country, there is often smuggling of the commodity so that the benefits of the policy do not fully accrue to those for whom it was intended Equity goals may be undermined by subsidies Large quantities of the subsidized inputs may be purchased by the rich and the large-scale farmers so that very little reaches the poor and small-scale farmers At the macroeconomic level, financing the subsidies strains the government budget and may misalign national priorities

Price supports

To the profit-maximizing producer a lower input price or higher output price or both will promote increased production In this respect apart from stabilizing prices and the incomes of producers output price-support schemes have been used to serve as incentives for the adoption of technology

Basically two types of price-support schemes have been implemented by countries that have instituted output price incentives (1) floor price support or guaranteed minimum price and (2) price band support

Floor price support

In the floor price, or guaranteed minimum price scheme, a price is set and interventions are introduced so that the market price does not fall below that price The intervention usually consists of purchasing excess produce from the market at the support price to prevent market forces from bringing the price below the guaranteed minimum level In figure 2, ABC is the demand curve and P_0 is the guaranteed minimum price or floor price of the commodity In the segment AB market forces determine the price When supply becomes greater than Q_0 the government purchases the excess at price P_0, so that the market price stabilizes at P_0 over the segment BC One major problem of the guaranteed minimum price scheme is the inability of the government or the implementing agency to purchase all excess supply that comes onto the market

Price band support

A basic price band policy can be illustrated by two graphs presented in figure 3 In the top graph P^* is assumed to be a target price that the govern

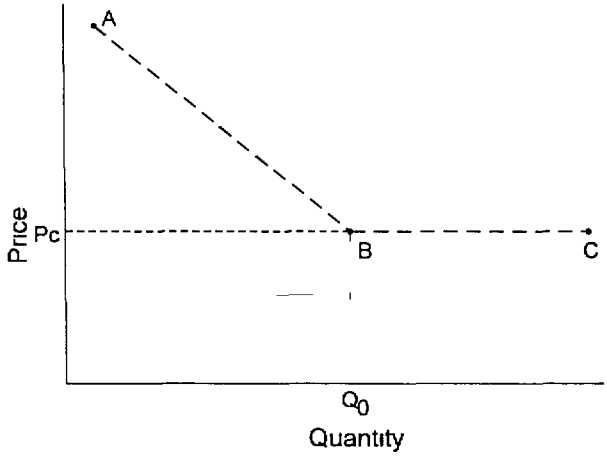

Fig 2 Floor price-support scheme

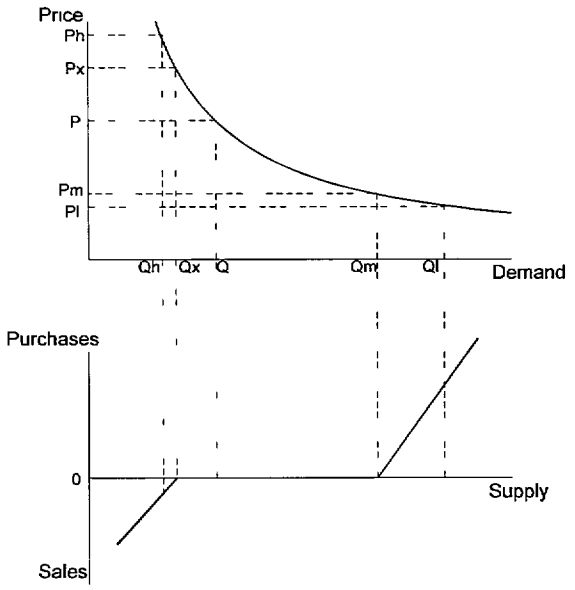

Fig 3 Price band policy

ment would like the market to attain P_x is the maximum price at which the government would sell sufficient maize to satisfy market demand P_x is therefore the trigger price for increasing supply P_m is the minimum price at which the government will purchase all the maize that it is offered and therefore serves as the trigger price for decreasing supply The width of P_x and P_m is the price band

The market is allowed to operate without any government intervention when the quantities demanded are between Q_x and Q_m If, in a given year, the actual production is Q_h, the market clearing price is P_h, which is higher than the ceiling price of P_x, so the government releases $Q_x - Q_h$ of maize onto the market for sale to keep the price at or below P_x Similarly, if actual production is Q_l, so that the market clearing price is P_l, which is below the floor price, the government removes $Q_l - Q_m$ of maize from the market through purchases so that the price rises to at least P_m

Supply and Distribution of Fertilizer in Ghana

Before privatizing fertilizer as part of the economic reforms program launched in 1983, the Crops Services Division of the Ministry of Agriculture (MOA) was responsible for determining annual requirements, coordinating procurement taking delivery of the fertilizer at Tema Port, and distributing it to its warehouses, regional stores, zonal stores, and farm services centers before redistribution to retail outlets There were about 400 MOA outlets for fertilizer throughout the country

In 3 of the 10 regions, Volta, Upper, and Northern, government-controlled FASCOM s (farmer service companies) had assumed MOA s role in the distribution and marketing of fertilizer In the Upper and Northern regions, there were at least 60 outlets for fertilizer and in the Volta region about 40 outlets

Problems that characterized the system during the period of sole public-sector management included ineffective fertilizer importation, untimely delivery due to poor assessment of demand, delays in procurement, slow rate of discharge at port, poor roads and communication, and unsuitable and inadequate storage facilities Inappropriate types of fertilizer were frequently imported—low analysis materials such as 15-15-15 and ammonium sulphate (20-0-0)

Imports of fertilizer have increased in recent years From an average of 1,403 tons per year between 1954 and 1962 and 6,683 tons per year over the following decade, average annual imports jumped to 32,731 tons between 1973 and 1980 Between 1984 and 1990, imports reached as high as 39,381 tons per year, however the actual quantities fluctuated markedly from year to year Indeed no import of fertilizer occurred in 1981 and 1983 (Tshibaka and Atsu 1992)

Privatization scheme for fertilizer

Studies of MOA fertilizer distribution activities showed that in the light of the government s trade liberalization policy, the private sector could handle the activity A privatization program was thus initiated in 1987 with the following objectives

- to phase out government subsidy on fertilizer over 3 years
- to encourage and register private retailers and wholesalers
- to train retailers and wholesalers in the storage and distribution of fertilizer

- to withdraw the MOA from the importation and distribution of the input over the 3 year period
- to have MOA the monitor the impact of the privatization program and make recommendations to government

Major features of the privatization of fertilizer imports and marketing policy under the program were

- Duty-free commercial imports
- Any organization firm or private party (local or foreign) could import and market fertilizer
- Any type or grade of fertilizer could be imported provided it was cleared with the MOA and the Environmental Protection Council
- Government official retail fertilizer prices (starting in January 1990) would be fixed on a full cost-recovery basis using the official exchange rate in effect at a time of purchase
- The government would maintain national uniform pricing but would not control the selling price of other importers
- The government would continue to import and market fertilizer until the private sector demonstrated the ability to supply the market and there was sufficient competition in the market to assume fair prices

To allow time to rebuild the distribution networks and infrastructure and to phase out subsidy, the privatization program was implemented over 4 years The phasing out process included a transition period during which the government took the responsibility for procuring and distributing fertilizer

In the first year private retailing of fertilizer was to be introduced in the Volta and Brong Ahafo regions on a pilot basis Dealers who intended to withdraw fertilizer from the national depot and retail it would be registered Retail margins would be computed by MOA in conjunction with the Prices and Incomes Board to enable the dealers to arrive at their retail prices Farmers groups and cooperatives were to receive the same terms as private retailers

In the second year the private retailing system was to be extended countrywide based upon the experience of the first year Retailers in all administrative regions were to pay and use uniform distribution point prices The retail prices were to provide for retailer margins based on the experience in the Volta and Brong-Ahafo regions In areas lacking retailers cooperatives or farmers groups, the FASCOMs would continue to operate

In the third year MOA would sell fertilizer only to wholesalers or dealers from its central stores at Tema Swedru Kukurantumi and Tamale Operation of pan-territorial pricing was to cease Internal marketing and distribution of fertilizer was anticipated to lie substantially in the hands of the private sector

In the fourth year, direct imports by private sector for an MOA-approved list of fertilizers were to be permitted

Table 1 Fertilizer prices and subsidies 1979-90

Year	Price (₵/50 kg bag) Compound fertilizer	Straight fertilizer	Subsidy (% of price)
1979	10	8	80
1980	15	12	65
1981	30	25	45
1982	30	25	45
1983	58	45	45
1984	440	295	45
1985	440	295	56/62
1986	780	490	36/66
1987	1 380	1 270	42
1988	2 300	1 600	30
1989	3 350	2 100	15
1990	4 200	3 500	0

Source Ministry of Agriculture 1990

Fertilizer subsidies

Before 1980 fertilizer was heavily subsidized (about 80%) but drastic adjustments in fertilizer prices were made in the 1980s (table 1) The fertilizer subsidy was costing the government about US$5 million a year without reaping the anticipated benefits due to poor management It therefore was planned to phase out the subsidy in tandem with the privatization scheme In the first year (1988), the subsidy level was dropped to 30% from 66% in 1986 and 42% in 1987 (table 1) There was a further reduction to 15% in 1989 and in 1990 the fertilizer subsidy was eliminated By the end of 1991, the whole fertilizer delivery system had been privatized and a free market system started operating (fig 4)

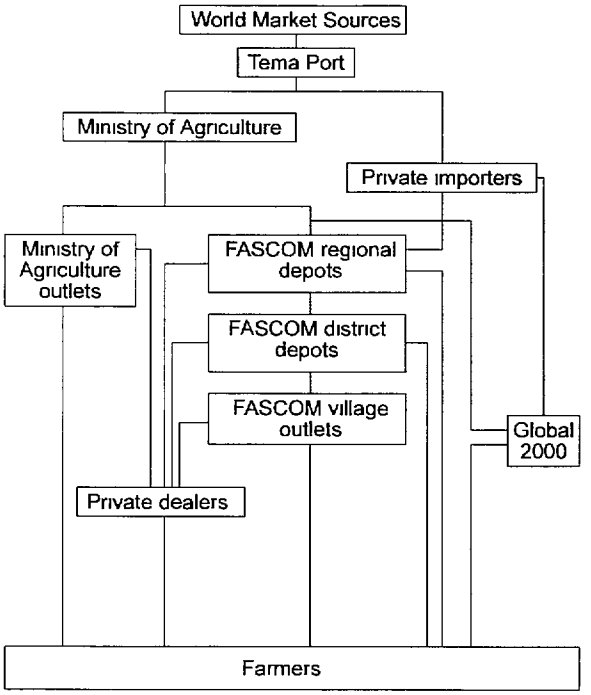

Fig 4 Product flow in the present fertilizer marketing system

Volumes and margins for fertilizers

When the private retailing of fertilizer was instituted in 1989, a crop input development unit (CIDU) was set up in the Crop Services Department of the MOA to implement the scheme Interested retailers were registered and CIDU worked out margins upon which they were to operate In 1989 the margin on a 50-kilogram bag of fertilizer was ₡150 for a minimum of 50 bags, ₡250 for a minimum of 500 bags and ₡600 for a minimum of 2 000 bags, These margins offered 4 5% 7 5%, and 17 9% return on investment, respectively When compared with other investment alternatives fertilizer retailing could only be justified for a minimum volume of 2,000 bags, which called for substantial investment at the unsubsidized prices Considering that the cost of borrowing capital was over 30%, the return on fertilizer retailing was not attractive at any level of operation Coupled with this low return was a weak demand for fertilizer

Performance of the fertilizer industry

Participation of the private sector in fertilizer supply and distribution has resulted in the availability of new forms of fertilizer High-yielding-capacity, low-analysis materials are being imported (for example, 22-20-0, 25-15-5, and urea) Import volumes have shown an upward trend since 1986 (table 2), though fertilizer use remains modest For instance, in 1989 a total of 65,239 tons were available, but sales amounted to 32 657 tons, and in 1990 43,350 tons were available, but 30 609 were sold

The response of the private sector to the opportunities created under the privatization scheme has generally been poor In 1989 only 14 of 351 registrants withdrew any fertilizer and in 1990 49 out of the 656 total registrants were active (table 3)

The number of active registrants increased significantly from 1989 to 1990 in Ashanti, Brong-Ahafo, and Northern Regions Of the total imports of 65 239 tons of fertilizer in 1989 only 285 tons were distributed by private retailers In 1990 the amount of fertilizers retailed by the private sector went up to 4,513 tons

In response to the permission given to the private sector to import fertilizer, the firm WIENCO imported 20,600 tons in 1990

Table 2 Ghana fertilizer imports, 1984-90 (metric tons)

Fertilizer	1984	1985	1986	1987	1988	1989	1990
Sulphate of ammonia	13 600	5 437	8 500	14 650	20 550	25 711	2 000
Single superphosphate			400				500
Muriate of potash			1 000	600	1 050	3 340	
Urea	200					6 015	20 000
15 15 15	24 550	21 365		4 800	9 400	8 000	4 250
17 17 17					5 075		
25 25 25/ 23 15 5						5 893	8 000
20 20 20/ 22 22 0		3 200	9 600	17 620	2 900	15 500	8 500
10 20 15			600	400	600	350	
Potassium nitrate						400	
Total	38 350	29 990	20 100	38 070	39 575	65 239	43 350

Source Sigma One Corp 1990

Table 3 Fertilizer privatization program Number of registered fertilizer dealers and active dealers

Region	Registrant			Active operators		
	1989	1990	1991[a]	1989	1990	1991
Western	7	7	7		1	N/A
Central	8	18	19		2	N/A
G Accra		9	23	29	1	3
Eastern	12	26	31			N/A
Volta	55	65	67	1[b]	1[b]	N/A
Ashanti	10	41	41	1	12	N/A
Brong Ahafo	86	107	107	8	14	N/A
Northern	103	286	293	1	14[c]	N/A
Upper West	24	34	38	1[c]	1[c]	N/A
Upper East	37	49	49	1	1	N/A
Total	351	656	681	14	49	

[a] June 30 1991 [b] FASCOM(VR) [c] FASCOM(UR)
Source Files of the Crop Services Department Ministry of Agriculture Agroplan Ltd 1991

Causes of low participation by the private sector

The privatization program for fertilizer was launched with other sector policies that should have been favorable for promoting massive private sector participation but unfortunately the initial interest was dissipated not long after the beginning of the program

With only about 10% participation in the scheme and an anticipated reduction in the future, the fertilizer privatization scheme is in jeopardy The low participation by the private sector has been attributed to the following problems some of which now have been rectified

- *Declining use of fertilizer* The elimination of subsidy and the exchange rate adjustments under the ERP have raised prices of fertilizer (table 4) Fertilizer sales thus fell to an estimated 8 400 tons of plant nutrients in 1990 compared with 29 000 tons in 1989 The decline in fertilizer use occurred at the same time that efforts were being made to privatize the industry This was not an encouraging situation for private-sector participation
- *Oversupply of MOA fertilizer stocks* With declining use of fertilizer large stocks were accumulated in the MOA warehouse (about 68 000 tons of product as compared with 25 000 tons of product sold in 1990) This oversupply had a discouraging effect on speculators and essentially led to a stoppage of importation of fertilizers by the private sector
- *Volumes and margins* The decision of the government to maintain fixed prices with margins tied to the purchases was not satisfactory to many entrepreneurs The rebates on purchases of less than 500 bags (50-kg each) provided retailers with insufficient profits to encourage substantial investments in the venture Thus few dealers entered the market and those who did handled small quantities in limited market areas The system of volumes and margins has been revised and consideration has been given to distances to some locations (table 5)
- *Continued participation of the public sector* The Extension Services Department and the Global 2000 program which purchase fertil-

Table 4 Fertilizer prices 1981-90 (₵/50 kg)

Year	15 15 15	20 20 20	$NH_4 SO_4$	17 17 17
1981	30		25	
1982	30		25	
1983	53		38	
1984	450		31	
1985	450		31	
1986	450	800	500	
1987	850	800	350	
1988	2 300	2 300	1 600	2 640
1989	3 550	3 350	2 350	3 600
1990	4 200	4 200	3 100	4 400

Source Files of the Crop Services Department Ministry of Agriculture

Table 5 Fertilizer margins for 1991

Purchase minimum	Discount rate (₵/50 kg bag)
Dealers buying from district and regional depots	
20 bags	400
100 bags	450
300 bags	500
500 bags	600
2 000 bags	800
Wholesalers buying from the national depot using own means of transport	
Greater Accra Eastern and Volta regions	
500 bags	700
2 000 bags	900
Ashanti Brong Ahafo Central Western Northern and Upper regions	
500 bags	850
2 000 bags	1 050
Wholesalers in the Northern and Upper regions collecting from the national depot at Tema	
500 bags	900
2 000 bags	1 100

Source Files of the Crops Services Department Ministry of Agriculture 1992

izer directly from the MOA or parastatal FASCOMs distributed about half of the fertilizer sold in Ghana in 1989 Continued direct sales by these two organizations dampened the enthusiasm of many private retailers

- *Lack of technical assistance* A privatized fertilizer supply and distribution business still requires certain services that can best be provided by the public sector Fertilizer is a specialized commodity the registered dealers should have been trained to handle the input, but such training was not organized
- *Lack of credit* There is widespread need for credit at all levels of the fertilizer trade and use Too few credit facilities and unreasonably high interest rates discouraged the sustenance of a dynamic and competitive privatized fertilizer industry This was true at the importer wholesaler retailer and farmer levels
- *Pan territorial pricing policy* The pan-territorial pricing policy created cross-subsidization because it did not take into consideration the differences in the cost of delivery Due to long distances and the conditions of the roads, the cost of delivering fertilizer to some locations is prohibitive The policy therefore impeded the growth of private marketing that could ensure regular and timely supplies to farmers in a cost-effective manner Differential pricing has now been introduced for some locations (table 5)
- *Output marketing* The existing poor market for cereals, especially locally produced rice, inhibited the development of private input marketing

Fertilizer Use

Chemical fertilizers are sparingly used in Ghana despite the low levels of available nitrogen and phosphorus in the soils—compare a 0 9 kg/capita use in 1988 in Ghana to 1 5 kg/capita in Mali, 6 5 kg/capita in Malawi and a global average of 28 5 kg/capita A 1990 FAO report on plant nutrients used per hectare of arable land and land under permanent crops revealed that among the 19 developing countries studied Ghana s fertilizer use was the lowest Fertilizers are used mostly on cereals, vegetables, and shallots Maize and rice are the predominant crops on which fertilizer is applied

Despite increased numbers of extension campaigns to encourage fertilizer use, consumption and sales have declined since the early 1980s—over 20,000 tons of fertilizer nutrients (N, P_2O_5 K_2O) were used annually before 1984 compared with less than 15,000 tons annually in recent times Within the different ecological zones, different levels of fertilizer are used, depending on the type of crop grown and to a lesser extent, on the inherent fertility of the soils For instance, the major crops cultivated in the rain forest belt are rubber coconut oil palm, cocoa, citrus, plantain, and cassava These crops are not, as a general rule, fertilized by Ghanaian farmers (Badiane et al 1992) However some supplementary fertilizer application is done on plantations by farmers using modern techniques

Fertilizer is largely used in the interior and coastal savanna zones where the cultivation of annual root crops and cereals predominate and where soils are inherently low in fertility However in spite of the significant response to fertilizer of many crops in Ghana, the number of farmers using fertilizer and the number of crops fertilized remain limited

A survey of some 1,200 small-scale farmers (less than 10 ha) randomly selected from the five ecological zones of the country showed that in 1989 only 18% used chemical fertilizers of any kind It further showed that only 30% had ever used chemical fertilizers The same survey showed that in 1987, 87% of the medium- to large-scale farmers (more than 10 ha) used fertilizers Most farmers in the survey used less than the recommended rates Over half of the farmers that used fertilizer applied less than the recommended rates As farm sizes increased, the percentage of farmers using the rec ommended rates declined (Sigma One Corp 1990)

A survey of farmers in three districts conducted for this study showed that there were pronounced differences in the fertilizer adoption rates between extension contact farmers and noncontact farmers The expectation that contact farmers will adopt innovations faster than noncontact farmers because of the former s interactions with extension staff was confirmed by survey results In both 1990 and 1991, over 60% of all contact farmers used fertilizer as opposed to under 40% of the noncontact

Table 6 Percentage of maize-growing farmers in three districts using fertilizer (extension contact farmers vs noncontact farmers growing maize) 1990 and 1991

Survey area	Contact farmers	Noncontact farmers
1990		
All farms	63 9	36 1
Hohoe	76 6	23 4
Nkoranza	66 1	33 9
Savelugu	50 0	50 0
1991		
All farms	67 3	32 7
Hohoe	77 5	22 5
Nkoranza	72 6	27 4
Savelugu	53 7	46 3

Source Survey data

farmers (table 6) This pattern was observed in Hohoe and Nkoranza districts but in Savelugu district there was no difference in 1990 and just a slight difference in 1991 In the Savelugu district there may be little difference between contact and noncontact farmers because other extension services are present in the district or nearby districts that treat all farmers the same The nearby Nyankpala Agricultural Experiment Station and the IFAD Smallholder Rehabilitation Program also diffuse technology so knowledge about fertilizer may be more widespread in the district than other areas of the country

Farmers in the surveyed area used three main fertilizers on their maize and rice crops various forms of NPK (15-15-15, 17-17-17 25-15-5 20-20 0 and 10-20-15) sulphate of ammonia and urea In 1990 54 8% of maize farmers and 17 5% of rice farmers who used fertilizer applied NPK to their crops 38 5% of maize farmers and 40 4% of rice farmers who applied fertilizer used sulphate of ammonia and 15 6% of maize farmers and 10 5% of rice farmers who applied fertilizer used urea (table 7)

Table 7 Use of fertilizer on maize and rice 1990

	Maize		Rice	
Fertilizer	Users (%)	Mean quantity used (mini bag/acre)	Users (%)	Mean quantity used (mini bag/acre)
NPK	54 8	1 69	17 5	0 75
Urea	15 6	1 81	10 5	0 78
Sulphate of ammonia	38 5	1 61	40 4	1 35

Source Survey data

Many of the farmers who applied fertilizer used less than the recommended amounts of the input, and this resulted in sub-optimal responses For instance instead of 2 bags (50 kg per bag) of NPK per acre for maize the average farmer who used fertilizer applied 1 7 bags (table 7) The major reason farmers gave for not using the recommended amounts of fertilizer was lack of funds (table 8)

Despite attempts to improve the supply of fertilizer farmers still find it difficult to obtain About one third of all the farmers who wanted fertilizer reported difficulties in obtaining it Even in the Volta Region where there are FASCOMs, about 27% of farmers complained about difficulties in obtaining fertilizer The major cause other than inadequate supplies is inefficiency in the distribution system Retail outlets are not close enough to the farmers

Survey data indicated that in 1990 less than 2% of the farmers purchased fertilizer from private retailers However the situation improved in 1991 with 27% of them obtaining their fertilizer from private retail outlets to diminish the dominant role of the Ministry of Agriculture (table 9)

Table 8 Reasons for not using the recommended quantity of fertilizers per acre of fertilized area

Reason	No of farmers	Percent
Limited funds	7	31 2
Fertilizer is too expensive	6	27 3
Lack of extension service and labor	4	18 2
Crop does not need all quantity recommended	2	9 1
Use farm manure/fertilizer not effective	2	9 1
Not aware of any recommendation	1	4 5
Shortage of fertilizer in the district	1	4 5
Difficult to contact extension officer	1	4 5
Total	22	100 0

Source Tshibaka and Atsu 1992

Causes of Low Levels of Fertilizer Use

The principal cause of low levels of fertilizer use by Ghanaian farmers are lack of knowledge un availability of fertilizer and high cost

Lack of knowledge Ghanaian farmers have many sources of information on fertilizer and its use such as MOA, FASCOM publications, and friends and relatives Yet a substantial number of them still do not use fertilizer due to lack of knowledge For instance the 1990 Ghana Grains Development Project (GGDP) survey indicated that 12%

Table 9 Sources of fertilizer 1990-1991

Source	Users (%) 1990	1991
Neighbor	0 6	1 2
Private retailer	1 4	27 4
Ministry of Agriculture	90 9	35 7
Public parastatal	4 5	15 3
NGO	2 6	20 4

Source Survey data

Table 10 Reasons for not using fertilizer on maize

Reason	Farmers (%) who never adopted	were disadopters[a]
Price too high	51	53
Soil is good	29	30
Fertilizer not available	3	8
Lack of knowledge	12	1
Other	5	9
Farmers (no)	138	117

[a] Disadopters once adopted the practice and discontinued it
Source GGDP 1991

of the 138 farmers who never adopted fertilizer on maize did so due to lack of knowledge (table 10) Tshibaka and Atsu (1992) also observed that in Ghana some crops are not fertilized because farmers lack information pertaining to fertilizer use on these crops

Unavailability As outlined earlier, unavailability of fertilizer may not be a major cause for low level of fertilizer use Table 10 indicates unavailability accounts for only 3% of the 138 farmers who never adopted fertilizer on maize and 8% of disadopter farmers However, another survey conducted in 1990 in three districts of the Volta Region established that 13% of the respondents saw unavailability of fertilizer as a constraint limiting its use (Agbola 1990)

High price of the input The devaluation of the cedi, coupled with the removal of the fertilizer subsidy, has led to significant fertilizer price increases in the last few years (table 1) This is a major reason for lower levels of fertilizer use in Ghana Over 50% of farmers surveyed by GGDP gave high fertilizer prices as the reason why they do not use the input (table 10) and 27% of the farmers in another survey did not use the recommended quantities of fertilizer because it was too expensive for them (table 8)

Other In Ghana both very heavy and very little rain make fertilizer ineffective (Agbola 1990) During these times, farmers preference not to use fertilizer is probably a risk management strategy

Agbola (1990) also observed that a few farmers (8%) believe that the taste of meals prepared from crops (especially maize) that have been heavily fertilized is changed, which lowers the crop s marketability (Agbola 1990) Others also believe that vegetables die early in fields where fertilizer is applied and that the crops tend to be more susceptible to disease The produce obtained from vegetable crops on which fertilizer has been applied are also thought to deteriorate very quickly after harvest (Agbola 1990)

The GGDP (1991) established from its survey that intercropping influences the use of fertilizer Farmers are more reluctant to use fertilizer on maize-cassava intercrop fields than on monocrop fields Land tenure is another factor that makes a difference Sharecroppers are less likely to invest in fertilizer (6%) than landowners (31%) Under the most common sharecropping arrangement, the sharecropper is responsible for all purchased inputs but must give the landowner one-third of the harvest the profitability of fertilizer in these cases is thus substantially reduced and therefore there is little incentive for its use Fertilizer use is also related to such recommended practices as random planting, local vs improved seed variety, and row planting (GGDP 1991) The use of fertilizer on monocrop maize is almost nonexistent on fields where farmers use random planting and grow local varieties of the crop The use of an improved variety increases the probability of using fertilizer, but it is mainly fields that are row planted that receive fertilizer In addition, fertilizer application is much easier in the fields that are row planted

Tshibaka and Atsu (1992) also established that some important staples such as roots tubers and plantain, cocoa and other tree crops are not fertilized because little fertilizer research has been done on them Furthermore, the government policy of promoting the use of the limited fertilizer imports for the production of cereals and legumes has also contributed to the small interest in the use of fertilizer on noncereal crops

Maize Marketing

Maize marketing involves both the private and public sectors The Ghana Food Distribution Cor-

Table 11 Volume of maize purchases by GFDC

Year	Volume (tons)		Purchases / production (%)
	Maize purchases	Total production	
1985	14 233	395 000	3 6
1986	14 150	559 100	2 5
1987	13 130	597 700	2 2
1988	17 860	600 000	3 0

Source GFDC and PPMED Ministry of Agriculture

poration is the main public agency involved in maize marketing To a lesser extent the Grains Warehousing Company and public-sector poultry and feedmill establishments also purchase maize Private maize retailing is done by market women who sell smaller quantities in standard assorted containers At the major maize markets like Kumasi and Techiman, there are wholesale traders who either take title to goods and sell for profit or work as commission agents and sell for assemblers for an established commission The assemblers are itinerant traders who move around the rural markets and houses and farms of producers and buy maize which is later sold in the urban or major maize markets The private sector controls over 90% of the maize market

Analysis of farm-gate and wholesale prices indicate that there are large variations in inter-year and intra year prices The year-to-year price fluctuations may be due to the weather and decisions of farmers based on their price expectations which are normally adaptive in nature Due to the scarcity of farmer owned storage facilities and high demand for money at harvest time farmers dispose of most of their produce at any price immediately after harvest Thus prices tend to be low at harvest time and high during the off season This gives rise to huge variations in intra-year prices which may call for a price-stabilization policy

It has been shown that the maize markets in Ghana are quite integrated (Asante Assuming-Brempong and Bruce 1989) A movement in price at one market is transmitted to other markets in a short time Dissemination of information is carried out by itinerant traders who travel long distances to purchase maize from the remote producing areas and sell it in the urban centers

To promote agricultural production on sustainable basis intervention was deemed necessary to deal with farm-income variability and food insecurity Ghana has transitory food insecurity that results from shortages due to erratic weather poor market infrastructure and households lack of access to credit There is also chronic food insecurity which reflects limited purchasing power in addition to some of the other conditions Due to the inelastic nature of the demand for food farm incomes tend to be low when there is a bumper harvest (and therefore prices are low) and vice versa Farmers respond to low farm-gate prices for a commodity by reducing the area planted in the following season Therefore the food insecurity problem cannot be successfully redressed without tackling variability in farm incomes Prior to October 1990 the government attempted to overcome the problem by directly intervening in the market

The government intervened in the maize market by instituting a floor price support scheme or a Guaranteed Minimum Price (GMP) scheme which was operated largely by the Ghana Food Distribution Corporation (GFDC) The GMP, which was derived on cost-plus accounting basis was usually announced by the government after planting but before harvesting began This late announcement did not allow the GMP to influence farmers crop acreage allocation decisions The GFDC was mandated to buy at the GMP but until 1986 it was also required to sell at a government specified price

The operation of a support price scheme is only meaningful when the government is a buyer of last resort This was not the case with the intervention policy on maize because the government was not in a position to purchase all the maize that was offered at the support price The GFDC could normally handle less than 6% of the marketable surplus of maize and less than 4% of total production (table 11) due to inadequate logistic and financial support Survey results indicated that although the peak buying period of GFDC was October to December, by the end of September 95% of the farmers had harvested about 93% of the total maize production in the main season (Okyere 1990) The farmers therefore were forced to sell their produce at low prices to pay for production loans to meet household expenditures and to prepare for the minor season It could be deduced from the low market share of GFDC that only a few farmers benefited from the operation of the GMP

The peak harvesting period occurs in August and September, and with minimal storage facilities

and the need for cash balances many farmers indicated that they needed GFDC most during that period When farmers could not get the GFDC to buy their maize at harvest time they became disillusioned with the corporation and sold to itinerant traders at any offer price Because at harvest time it is a buyers market the traders asked the farmers to fill their expanded jute sacks to levels that might weigh 20 to 30% more than the weight of a maxi-bag of maize (100 kg) accepted by GFDC The transaction price was also usually a price dictated by the traders

When there is market failure the intervention of the government is desirable The government intervened in the maize market of Ghana in a price-support scheme with the objective of ensuring remunerative prices for maize farmers The price incentive was to promote increased maize production through the adoption of improved practices including the application of fertilizer However the price-support scheme failed to provide the requisite incentives due to deficiencies that have already been discussed The scheme was therefore not able to provide the anticipated response because fertilizer consumption still remained low even during the period when the scheme was in operation

Conclusions

The deterioration that was experienced in the Ghanaian economy in the 1970s and early 1980s did not spare the agricultural sector Output of both food and cash crops declined over the period As a result of efforts made under the Economic Recovery Program the agricultural sector has turned round but the modest increases in production have not been enough to meet the increasing demand for food and fiber A way out of this demand squeeze is to improve the low productivity of farmers in Ghana, which has been attributed largely to low use of fertilizer

One major problem with Ghanaian soils is the low level of available nitrogen and phosphorus, exacerbated by shortened fallow periods It has been estimated that about 332,000 tons of ammonium sulphate would be required to replace the total amount of nitrogen annually removed by crops and about 116,000 tons of single superphosphate or 330,000 tons of 15 15 15 compound fertilizer would be required to replace the potassium annually removed by crops (Agroplan 1991) At the present levels of supply, it is doubtful that Ghana can meet these requirements Even if the fertilizers were available, there is evidence that farmers could not afford them at current prices

Some of the factors that have led to low use of fertilizer have arisen out of the pricing and distribution policies of the government introduced under the ERP The removal of subsidies from fertilizer in the absence of credit and remunerative output prices has resulted in a fall in demand for the input Marketing channels for fertilizer have functioned poorly even after the privatization of the supply and distribution of fertilizer, signifying a case of market failure The scant participation of the private sector in the retailing, wholesaling, and importation of fertilizer has been attributed to the low relative profitability of the enterprise resulting from narrow margins allowed by the Ministry of Agriculture

Apart from distribution problems and high input prices, another reason for the low utilization of fertilizer is the absence of remunerative output prices, which is also a result of output market failure Although the cereal market is fairly integrated, the inter-year and intra-year price variations often lead to large variations in farm incomes Market failure has been an argument for governments to intervene in markets by establishing regulations and price policies, but the output price-support scheme introduced by the government for selected commodities had to be canceled because it was not effective

A reduction in post-harvest losses, availability of effective storage structures, and an improvement in transport infrastructure can increase the profitability of many crops, especially the cereals and serve as an incentive for increased use of fertilizer

Literature Cited

Agbola F W 1990 Subsidies and price response in Ghana A case study of fertilizer use in the Volta Region B Sc dissertation Dept of Agr Econ Univ of Ghana, Legon

Agroplan Ltd 1991 Monitoring the agricultural production promotion program An assessment and impact study Research report to the Ministry of Agriculture Accra

Asante F O S Assuming Brempong and P A Bruce 1989 Ghana Grain marketing study Background paper for the Ghana Medium Term Agricultural Development Program Ministry of Agriculture Ghana

Badiane O V Nyanteng and A Seini 1992 Food security comparative advantage and fertilizer use in Ghana Institute of Statistical Social and Economic Research Legon Ghana

FAO 1989 *Fertilizer yearbook 1988* Rome

GGDP (Ghana Grains Development Project) 1991 *A study of maize technology adoption in Ghana* Kumasi Ghana Crops Research Institute

Ministry of Agriculture 1990 Medium term agricultural development program Accra

Okyere W Asenso 1990 *Guaranteed minimum price for maize An assessment of its effectiveness for future policy formation* Ghana Medium Term Agricultural Development Program Research Report No 1 Accra Ministry of Agriculture

Sigma One Corp 1990 Midterm evaluation of the APPP Report PAAD No 641 0117 USAID/ Accra

Tshibaka Tshikala and S Y Atsu 1992 Agro economic potential of fertilizer use in Ghana A study of constraints Institute of Statistical Social and Economic Research Legon Ghana

Market Integration The Case of Dry Season Vegetables in Nigeria

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SUMMARY

Vegetable crops not only improve the nutritional quality of Nigerian diets, the production of vegetables under irrigation and their marketing provide many people with employment in the dry season However because vegetables are highly perishable, the marketing risks are substantial and marketing inefficiencies are costly The prevailing high prices in urban retail markets and low prices at the farmgate level result from poor marketing infrastructure and services as well as insufficient policy-oriented marketing research

This study aimed at obtaining indices of marketing inefficiency through the market integration approach and to offer some solutions Weekly price data for pepper (*tatashe*) and tomatoes were collected from eight locations—four producing areas, two producing/consuming areas and two consuming areas—for 34 weeks (November 1991 to June 1992) and a Ravallion-type model was used to analyze market integration between pairs of markets

The results indicate that there is little, and a low degree of integration of pepper and tomato markets in the study area as a whole Some market integration however exists between major producing and major consuming areas The results also indicate that good access roads are important for markets to be integrated, but the distance between markets is not Also the cobweb problem seems to be present and micro-level social, political, and economic factors significantly affect vegetable marketing decisions

The conclusion is that a major determinant of market integration in the study area (and possibly in Nigeria as a whole) is information flows between producing and consuming areas and that assemblers of the produce, primary wholesalers and transporters are currently the major sources of the information That is clearly unsatisfactory for efficient marketing of produce There is need for the federal and state governments to give priority attention to daily or weekly collation and dissemination of foodcrop marketing information especially prices to improve marketing efficiency and consequently production of foodcrops generally and dry season vegetable crops in particular Other policy issues worth pursuing to improve marketing efficiency include eliminating secondary wholesalers from the marketing chain, beginning an insurance scheme for vegetable marketers, encouraging small-scale processing of vegetables, and instituting effective extension services for dry-season vegetable producers and marketers

The marketing of agricultural products in many developing economies, with their largely unorganized foodcrop markets, is a major determinant of development generally and agricultural development in particular In Nigeria, foodcrop marketing has largely been in the hands of small-scale marketers with minimal support from the government agencies Government emphasis

has been on food production It is agreed that food marketing (and production) should ideally be handled by private individuals and firms however the necessary marketing infrastructure has to be in place and a conducive environment created for efficient marketing of produce As stated by Olayemi (1972) production and marketing constitute a continuum and lack of development in one retards progress in the other To increase food production there is the need to develop a more efficient marketing system for the various crops

In the past the federal state and local governments of Nigeria have attempted to provide some marketing infrastructure and services for export crops grains and other staples Little attention has been given to the marketing of vegetables, such as peppers tomatoes onions garden eggs okra and leafy vegetables in spite of the fact that they need special marketing facilities and organization due to their highly perishable nature Also most of these vegetables are cultivated in the dry season under irrigation in the northern part of the country and transported to consumption centers in the south This again implies that special marketing arrangements have to be made for assembling produce packaging transportation storage at the wholesale level and sale within a short time

Although considerable research has been done on the marketing of grains in Nigeria (Jones 1968, 1972 Anthonio 1968 Gilbert 1969 Thodey 1969, Hays 1975 Ejiga 1977 Hays and McCoy 1978, Berg 1980 Ingawa 1983) hardly any has been done on vegetable crops particularly the dry season vegetable crops for which many of the major consumption centers are not production centers

Vegetable crops though not staple crops in Nigeria are important for almost every household Most Nigerians include pepper tomatoes onions and leafy vegetables in their diets They add flavor to the food They also provide considerable protein, vitamins and minerals

In addition the cultivation of dry season vegetables by irrigation employs many people who otherwise would have little income for about half the year Dittoh (1992) reported that dry season vegetable production in Nigeria has become a booming business Apart from the farmers and farm laborers who produce the vegetables there are many people engaged in moving produce from the producer to the consumer It is therefore important to many individuals and to the nation that the marketing of dry season vegetables be as efficient as possible The more efficient the marketing system the more rewarding it is to everyone involved in the production marketing, and consumption of the produce

Research Problem and Objectives

The food marketing system in Nigeria is largely unorganized and inefficient Post-harvest problems from the farm to the retail level result in high losses high costs of foodstuffs and disincentives and discouragement to producers marketers, and consumers The problems are acute for dry season vegetable crops There has however been little research on ways to improve the efficiency of dry season vegetable marketing in Nigeria In fact there seems to have been no previous attempt to determine the efficiency of vegetable markets in the country through the market integration approach The market integration approach to the measurement of marketing efficiency is based on the premise that an efficient (commodity) market will establish prices that are interrelated through space by transportation costs and through time by storage costs (Bressler and King 1970) If a market is integrated, there will be low variation in prices across space and over time Another implication is that prices of commodities in spatial markets will be functionally related in one form or another

The broad objective of this study therefore was to obtain indices of marketing efficiency of some vegetable markets by investigating their levels across integration space for a production season Specifically the study sought to

- identify and study the marketing channels of several dry season vegetable crops
- determine the spatial market integration of pepper (*tatashe*) and tomato markets for a production season
- identify factors that might be causing low market integration and marketing inefficiency in the vegetable markets and to suggest remedies

Marketing Efficiency and Market Integration

Among the factors that determine the efficiency of a marketing system is the type of market structure that prevails Marketing efficiency is more likely to be high in a competitive market than in a less competitive one In fact, the ideal market structure for optimal marketing efficiency, *ceteris paribus*, is pure competition In Nigeria, dry season vegetable markets can, under conducive environments be very competitive Dry season vegetables are grown by many small farmers and production is concentrated in specific locations Also a relatively large number of buyers are involved in the vegetable trade especially at the retail level There are however relatively few marketers at the wholesale level because of problems of assemblage and the highly perishable nature of the produce

The issues of marketing efficiency and market competitiveness have long been areas of controversy Some researchers have claimed that the existence of many intermediaries in the marketing chain results in marketing inefficiencies (Adegeye and Dittoh 1986), but others have argued that it ensures efficient use of available resources (Wilcock 1978) Also, while Miracle (1968) argued that prices are competitive and therefore low at the farmgate and rural retail markets but are uncompetitive and thus high after the produce leaves local assembly markets, Anthonio (1973) said the issue of competitiveness is not a major determinant of high urban prices Rather the major cause is high marketing costs resulting largely from poor storage, high transport costs, and high degree of risks

An even more important controversy centers on the use of market integration measures to infer marketing efficiency Jones (1968, 1972), Gilbert (1969), Thodey (1969), and others have used the bivariate correlation coefficient to measure market integration and to infer marketing efficiency Others have however criticized the use of this measure and have shown its inappropriateness in inferring market efficiency (Blyn 1973, Harriss 1979, Eicher and Baker 1982) It has nevertheless been shown that market integration studies using appropriate methodologies do determine the efficiency of price transmission between markets (physical markets) (Ravallion 1985, 1986 Heyten 1986, Faminow and Benson 1990, and Dahlgran and Blank 1992) That means the more integrated a (commodity) market is, the greater the marketing efficiency because the variation in price across space and over time will be lower In fact in an integrated (commodity) market, there will be less covariance between individual outputs and the aggregate supply, thus implying less risk and higher incomes Therefore, market integration is indeed a good measure of, or a proxy for, marketing efficiency if it is determined appropriately

The Ravallion Method and its Extensions

The model that seems to have revolutionized agricultural market integration research is that of Ravallion (1985, 1986) and its extension by Heyten (1986) and others to include what is termed the Timmer index Faminow and Benson (1990) as well as Dahlgran and Blank (1992) have also made relevant extensions to the model

The basic Ravallion model seeks to determine whether a change in the price of a commodity in a 'local' market is influenced (determined) by the change in price in a central ' or reference market The model assumes an autoregressive distributed lag relationship between prices of a commodity in the local market and those in the reference market The simplest form of the model might be given as

$$P_i = f_i(P_1, X_i) \quad i = 2 \ldots m \qquad (1)$$

where P_i is the price in the local market, P_1 is the price in the reference market, X_i is a vector of non-price exogenous variables influencing the demand for and supply of the commodity in the local market, and m is the number of physical markets (locations) under study Usually relationships between prices in several local' markets and those in the reference market are studied

As a distributed lag model, equation (1) may be explicitly stated as

$$P_{it} = \sum_{k=1}^{n} a_{ik} P_{it-k} + \sum_{k=0}^{n} b_{ik} P_{1t-k} + c_i X_{it} + U_{it}$$

where a_{ik}, b_{ik} and c_i are the regression coefficients and n is the number of lags There is or there is not

market integration depending on the statistical significance of b_{ik}

The extension by Heyten (1986) makes it possible to directly test hypotheses as regards integration while that by Dahlgran and Blank (1992) tries to generalize the Ravallion model by not making any assumption about local and reference markets Instead they assume that both producers and consumers are dispersed through all markets to the extent that no market specializes in either production or consumption

The Analytical Model

The model used in this study is basically Raval lion (1985 1986) but more in line with the extension suggested by Dahlgran and Blank (1992) It however has some distinctive characteristics that have arisen mainly because of the nature of the commodities being studied Storage (of the commodities being studied) for example can be assumed to be nonexistent because they are stored only when there is lack of market They are not stored for the creation of time utility High losses are in fact incurred if lack of market compels marketers to store them for more than a week or so

A formal statement of the model used in the study is as follows

$$P_i = f(P_j, X, T)$$

$$P_j = f_j(P_i, X_j, T)$$

$$i, j = 1 \ldots m \text{ for } i \neq j$$

where

P_i, P_j are the prices of a particular vegetable type in markets (locations) i and j respectively

X, X_j are the vectors of seasonal influences on markets i and j respectively Two dummy variables were used to reflect the seasonality and hence the demand supply situations as well as any other special characteristics in the markets at the specific periods The dry season (irrigation season) was divided into three November to mid February to reflect low but increasing supply Mid February to April to reflect the period of abundant supply and May to June to reflect declining supply

T is the trend

m is the number of markets (locations) being considered (Eight in this study)

The model becomes more relevant if it is dynamized to obtain distributed lag equations as follows

$$P_{it} = \sum_{k=1}^{n} a_{ik} P_{it-k} + \sum_{k=0}^{n} b_{ik} P_{jt-k} + c_i X_{it} + d_i T + U_{it} \quad (2)$$

$$P_{jt} = \sum_{k=1}^{n} \alpha_{jk} P_{jt-k} + \sum_{k=0}^{n} \beta_{jk} P_{it-k} + \lambda_j X_{jt} + \gamma_j T + U_{jt} \quad (3)$$

$$i, j = 1 \ldots m \text{ for } i \neq j$$

where n is the number of lags In this study two-period lags (a period is 1 week) were assumed because of the highly perishable nature of the commodities

The above statements of the model imply that every market (location) is being regarded as local and as reference with respect to every other market That is no assumption is being made as to which price determines another It is recognized that while prices in consuming (reference) areas are usually expected to determine those in producing (local) areas the opposite can be true especially for highly perishable commodities such as vegetables Prices in producing areas reflect the supply situations in those localities and do at times determine prices in the consuming areas This is because the produce has to be transported to the consuming areas (markets) within a short time and there is virtually no storage as explained earlier The above analytical method was also used because it is more relevant to determine market integration across the whole geographical area under study than only pairs of locations Eight locations were chosen for the study, so 56 regression equations had to be estimated for each of the crops, pepper and tomato

Equations (2) and (3) were estimated as single equations rather than as systems of simultaneous equations mainly because I believe indirect effects are minimal and insignificant due to the nature of the produce and thus any resulting simultaneous equation bias would be negligible The types and levels of market integration were determined by the significance of the regression coefficients of $P_{jt\,k}$ and $P_{it\,k}$ (which indicate direct effects) and the Timmer indices, which are also referred to as indices of market concentration (IMC) Durbin s h statistic and the Godfrey test (Godfrey 1978) were used to test for the absence of serial correlation of residuals

The various market integration tests were used as follows

- Complete market segmentation or concentration (i e , no integration) $b_{ik} = 0$ and $\beta_{jk} = 0$ for $k = 1$ and 2 $k = 0$ is not considered relevant because the produce has to be transported or price information has to be transmitted by marketers and that takes time It cannot be instantaneous
- One-way market integration $b_{ik} = 0$ but $\beta_{jk} \neq 0$ or $b_{ik} \neq 0$ but $\beta_{jk} = 0$ for $k = 1$ and 2
- Two-way market integration $b_{ik} \neq 0$ and $\beta_{jk} \neq 0$ for $k = 1$ and 2

If there is market integration (one-way or two-way), it could be short-run strong form short-run weak form, or long run This classification can be easily done from the regression results What was however considered relevant in this study was whether there was market integration or not, as well as whether the integration was high or low using the IMCs

$$IMC_i = \text{Absolute}(a_{i1}/b_{j1}) \text{ or } \text{Abs}(a_{i1}/b_{j2})$$

$$IMC_j = \text{Abs}(\alpha_{j1}/\beta_{i1}) \text{ or } \text{Abs}(\alpha_{j1}/\beta_{i2})$$

It should be noted that a_{i1} b_{j1}, and b_{j2} are the coefficients of $P_{it\,1}$ $P_{jt\,1}$, and $P_{jt\,2}$, respectively, and α_{j1} β_{i1}, and β_{i2} are the coefficients of $P_{jt\,1}$ $P_{it\,1}$ and $P_{it\,2}$, respectively IMC lies between zero and infinity and the closer it is to zero, the greater the degree of short-run market integration Unity is used to indicate high or low short-run market integration IMC < 1 implies high short-run market integration, IMC > 1 implies low short-run market integration, IMC = infinity implies market segmentation or concentration

The Study Area and Data Collection

The study area comprised production and consumption areas in Kaduna and Niger states and two major consuming centers in Kwara and Oyo states of Nigeria Kaduna, Niger, and Kwara states fall within the middle belt of the country while Oyo State is in the southwest Dry season irrigated vegetable production is practiced extensively in the middle belt especially in Kaduna and Niger states (in addition to states further north in the country)

The towns and cities in which data were collected are Zaria, Kaduna, and Birnin-Gwari in Kaduna State, Minna, Wushishi and Bida in Niger State, Ilorin in Kwara State and Ibadan in Oyo State Zaria, Birnin-Gwari, Wushishi and Bida are producing areas Kaduna and Minna are producing/consuming areas Ilorin and Ibadan are principally consuming areas

Ibadan, Kaduna, Ilorin, and Minna are state capitals Zaria and Bida are relatively big towns, Birnin-Gwari and Wushishi are small towns Birnin-Gwari is however located on a major north-south trunk road, while Wushishi is located in the hinterland far from any trunk road Towns and cities with such diverse characteristics were selected to ensure comprehensive study of the relationships between the diverse vegetable markets

The study basically required price data which are however seldom available from government agencies or any organized private source Even when data can be found they are unreliable or limited to certain areas and specific food items Also the prices of various vegetables fluctuate so widely from day to day that monthly averages are not adequate for rigorous price analysis Weekly price data were therefore collected from a number of markets within the eight locations for 34 weeks from the first week of November 1991 to the last week of June 1992 November to June approximately constitutes the dry (irrigation) season in the producing areas Prices were collected for pepper (*tatashe*) and tomatoes Prices of produce in local units of baskets and bags were collected and conversions made to standard units For more details on field data collection and conversions to standard units see Dittoh (1993)

Marketing Channels

Marketing of dry season vegetable crops in Nigeria can be divided into two types One involves considerable assemblage and contract purchasing by wholesalers and the other does not The marketing of pepper, tomatoes and onions belongs to the former category while the marketing of other vegetables such as garden eggs carrots fresh okra and leafy vegetables belongs to the latter category

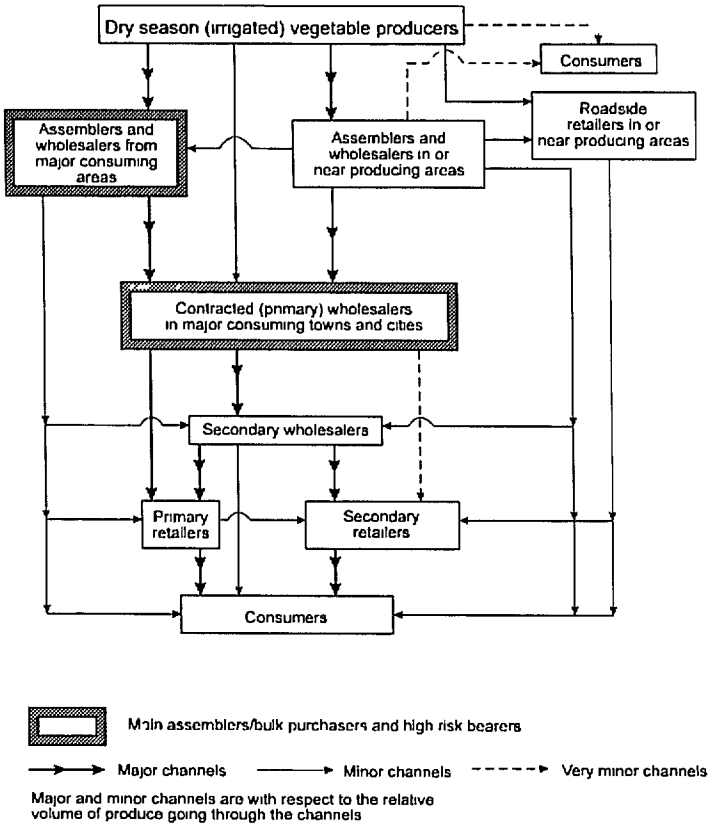

Fig 1 Marketing channels for irrigated pepper tomatoes and onions in Nigeria 1992

Figures 1 and 2 give the marketing channels for the two types of marketing systems As shown in figure 1 assemblers and primary wholesalers have to sell the produce through primary and secondary wholesalers as well as through primary and sometimes secondary retailers The numbers of groups of intermediaries between the producers and consumers are however not constant and it is logical to believe that the more groups of intermediaries there are the higher are the prices that will be paid by consumers *ceteris paribus* The implication is that the more groups of intermediaries there are the less integrated the vegetable markets will be across space Marketing efficiency will thus be improved if fewer groups of intermediaries are involved The term groups of intermediaries is used to indicate that the case being made for fewer groups of intermediaries does not imply that the numbers within groups should be small In fact for more competitiveness the numbers within the groups should increase More people should for example be encouraged to be assemblers at the farmgate level However secondary wholesaling should be discouraged

No vegetable wholesaler in the study area had cold storage facilities and none that we talked to planned to get any They believed it will not be profitable to invest in cold storage

Retailing of vegetables is done in almost all market places in the villages, towns, and cities Retailing is also done along highways in garages (lorry parks), in railway stations, and even from house to house A few supermarkets in towns and cities also retail vegetables especially to the relatively affluent members of the society These supermarkets have some cold storage of vegetables however, the quantities involved were too small for consideration in this study

Vegetable Market Integration

As mentioned earlier the statistical significance of the coefficients of the lagged exogenous vari

ables $P_{jt\,1}$ and $P_{jt\,2}$ for equation (2) and $P_{it\,1}$ and $P_{it\,2}$ for equation (3) indicate whether or not there is market integration between any given pair of markets (locations) Also the values of the indices of market concentration indicate whether the integration is high or low Tables 1 and 2 give the market integration results for pepper and tomato markets, respectively (Only the relationships that indicate some integration are presented in tables 1 and 2 The complete regression results for pepper are presented in table 3) Only 16 pairs of pepper markets and 14 pairs of tomato markets out of the 56 pairs for each vegetable indicate some integration Also for pepper only five market pairs indicated high integration and for tomato only two market pairs did The general conclusion therefore is that for these vegetables there is little and a very low level of market integration in the study area and possibly in the whole country The data also show that the distance between markets (locations) either is not a determinant or is a very poor determinant of vegetable market integration

The 16 pairs of pepper markets that show some integration (table 1) are basically pairs of producing and consuming areas Zaria and Bida, two important pepper-producing areas, are integrated with pepper markets in Ibadan, Kaduna, and Ilorin, which are the main consuming areas There is very little market integration between producing areas and between consuming areas An important exception however is Ilorin and Ibadan Ilorin serves as a transit point for produce meant for markets in Ibadan, so prices in Ilorin influence those in Ibadan, and vice versa

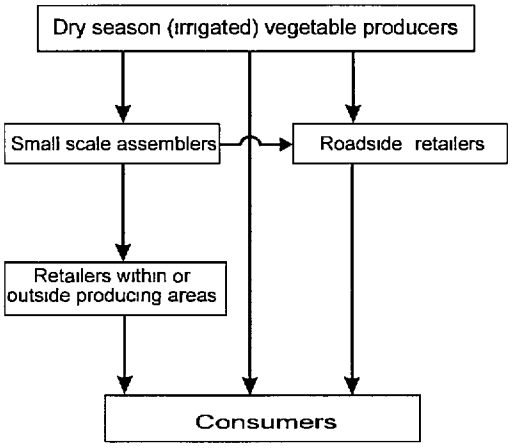

Fig 2 Marketing channels for other dry season vegetables (garden eggs, carrots, okra, and leafy vegetables), Nigeria, 1992

The tomato market integration results (table 2) reveal slight differences from those for pepper It is Zaria and Birnin-Gwari markets (and not Bida) that are integrated with tomato markets in the major consuming cities of Ibadan, Kaduna, and Ilorin The results also indicate some market integration between the major consuming areas but not the producing areas

Tables 1 and 2 also indicate the importance of good access roads for market integration and hence marketing efficiency Wushishi and Minna markets are not integrated with markets in major consuming areas mainly because of their remoteness from the main north-south trunk roads

It is interesting that in several cases the coefficients of $P_{2t\,1}$ and $P_{2t\,2}$ (tables 1 and 2) are negative and significant, suggesting that high lagged prices in reference markets have the effect of lowering prices in local" markets That is so because many factors other than price movements in consuming areas determine marketers behavior and expectations, and for given demand/supply situations it is their expectations and behavior that greatly determine prices in the 'local" markets Apart from the fact that the cobweb problem is to some degree present in vegetable marketing in Nigeria, short-run social, political, and economic factors do affect vegetable marketing decisions significantly High prices of dry season vegetables in an urban market could signal the imminent flooding of the market with vegetables, or the direct opposite depending on several micro-level social, political, and economic factors Civil unrest or a strike by transporters for a couple of days can mean very high losses for a vegetable marketer because of the highly perishable nature of the produce and the lack of storage

The inference drawn from the analysis is that the major determinant of vegetable market integration is information flows between producing and consuming areas The sources of the information are obviously marketers, especially the assemblers and primary wholesalers who regularly go to producing areas from the major consuming areas as well as transporters There is virtually no integration be-

Table 1 Pepper market integration results

Market 1	Market 2	Approx distance (km)	P_{1t-1}	$P_{1t\,2}$	P_{2t}	$P_{2t\,1}$	$P_{2t\,2}$	R^2	IMC	Classification
Zaria	Ibadan	700	0 6251	0 0837	0 1504	–0 2698	0 1860	0 9776	3 3608	Two way short run integration
			(0 1893)	(0 1702)	(0 0693)	(0 0899)	(0 0818)			
Ibadan	Zaria	700	1 0277	–0 6104	1 1309	–1 2647+	0 1152	0 7996	0 8126	
			(0 1967)	(0 2123)	(0 5208)	(0 5724)	(0 4684)			
Kaduna	Zaria	80	0 8787	–0 3091	0 2454	0 1769	–0 4227	0 9817	2 0788	One way short run Integration
			(0 1428)	(0 1409)	(0 1269)	(0 1357)	(0 1241)			
Zaria	Ilorin	535	0 5811	0 0704	0 4410	–0 5052+	0 2478	0 9784	1 1502	Two way short run integration
			(0 1996)	(0 1826)	(0 1523)	(0 2334)	(0 1854)			
Ilorin	Zaria	535	0 9610	–0 2222	0 6058	–0 5785+	0 0536	0 9494	1 6612	
			(0 2234)	(0 2208)	(0 2092)	(0 2456)	(0 2145)			
Zaria	Bida	470	0 5462	0 1348	0 5053	–0 4991+	0 3202	0 9812	1 0944	One way short run Integration
			(0 2004)	(0 1760)	(0 1427)	(0 1839)	(0 1889)			
Zaria	B/Gwari	200	0 3450+	–0 0775	0 6770	–0 6631	0 4378	0 9879	0 5203	One way short run Integration
			(0 1642)	(0 1478)	(0 1197)	(0 1757)	(0 1534)			
B/Gwari	Ibadan	500	1 1802	–0 3061	0 1698	–0 2088	0 1316	0 9432	8 9656	Two way short run integration
			(0 2168)	(0 2463)	(0 0952)	(0 1215)	(0 0995)			
Ibadan	B/Gwari	500	0 8693	–0 4939	0 7159	1 6129	0 6143	0 8210	0 5390	
			(0 1933)	(0 1851)	(0 4013)	(0 5835)	(0 5065)			
B/Gwari	Bida	247	0 9380	–0 0086	0 5793	–0 5146+	–0 0909	0 9611	1 8228	One way short run Integration
			(0 2192)	(0 2592)	(0 1645)	(0 2192)	(0 2521)			
Bida	Ibadan	445	0 9969	–0 5165	0 2254	–0 3589+	0 2139	0 7567	2 7877	Two way short run integration
			(0 2531)	(0 2796)	(0 1094)	(0 1422)	(0 1036)			
Ibadan	Bida	445	0 9679	–0 4901	0 6917	–1 9807	0 5913	0 8846	0 4887	
			(0 1962)	(0 1692)	(0 3356)	(0 3983)	(0 5102)			
Kaduna	Bida	480	0 7407	–0 2602	0 1442	–0 0642	–0 3179+	0 9788	2 3300	One way short run integration
			(0 1692)	(0 1469)	(0 1212)	(0 1399)	(0 1419)			
Ilorin	Bida	280	0 7404	–0 0453	0 7331	–0 5608+	–0 0199	0 9675	1 3203	One way short run integration
			(0 2502)	(0 2382)	(0 1584)	(0 2210)	(0 2495)			
Ilorin	Ibadan	165	1 2512	–0 2984	0 3759	–0 3095+	0 2036	0 9571	6 1450	Two way short run integration
			(0 2486)	(0 2538)	(0 0946)	(0 1318)	(0 0947)			
Ibadan	Ilorin	165	0 8318	–0 4427	1 0834	–2 1013	0 7144	0 9140	0 3958	
			(0 1788)	(0 1501)	(0 2725)	(0 4270)	(0 4179)			

$p < 0\,01$ $+p < 0\,05$ Standard errors are in parentheses

Notes

1) $P_{2t\,1}$ and $P_{2t\,2}$ represent $P_{jt\,1}$ and $P_{jt\,2}$ as well as $P_{it\,1}$ and $P_{it\,2}$ depending on which market is regarded as local and which as reference

2) IMC = Index of market concentration (Timmer index) IMC < 1 implies high market integration IMC > 1 implies low market integration

3) The coefficients of the dummy variable and the trend have been excluded in the presentation of the results

4) R^2 values presented only to indicate their irrelevance in determining market integration by the method used

5) Durbin s *h* and Godfrey statistics have not been presented but they indicate absence of serial correlation of residuals

tween producing areas because of the lack of information flows between them Currently the assemblers and wholesalers seem to be concentrated in Zaria Birnin-Gwari and Bida because they are along major north-south trunk roads The fact that the integration between the few markets is generally low underscores the need for improvement of the role being played by assemblers and wholesalers as well as other market intermediaries

Policy Implications

The marketing channels and the market integration results all indicate that vegetable marketing efficiency needs to be improved and that can be done by a combination of several policy measures There is a need to improve the provision of basic marketing information especially on prices With current communication technologies information on daily or weekly prices of produce could be easily collated and disseminated if the federal and state governments considered such a service a priority for the improvement of agricultural marketing generally and the marketing of dry season vegetables in particular This is a service the governments must provide to motivate the private sector to invest in agricultural marketing

Table 2 Tomato market integration results

Market 1	Market 2	Approx distance (km)	$P_{1t\,1}$	$P_{1t\,2}$	$P2t$	$P_{2t\,1}$	$P_{2t\,2}$	R^2	IMC	Classification
Zaria	Ibadan	700	1 2993	–0 3579	0 1562*	0 3667	–0 2099	0 9779	3 5432	Two way short run integration
			(0 1785)	(0 1896)	(0 0544)	(0 0746)	(0 0725)			
Ibadan	Zaria	700	1 1559	–0 3887	–1 6894	2 3379	–0 2693	0 9680	0 4944	
			(0 2556)	(0 2666)	(0 5884)	(0 9492)	(0 6678)			
Zaria	Kaduna	80	0 7695	–0 1632	–0 2827	0 3926	0 0086	0 9806	1 9600	One way short run integration
			(0 2134)	(0 2064)	(0 0712)	(0 0991)	(0 1074)			
Zaria	Ilorin	535	0 6946	0 0414	–0 0775	0 3076+	–0 0027	0 9726	2 2581	Two way short run integration
			(0 2076)	(0 2049)	(0 1054)	(0 1141)	(0 1050)			
Ilorin	Zaria	535	0 7719	–0 1585	–0 2959	–0 1563	0 9696+	0 9535	0 7961	
			(0 1989)	(0 2026)	(0 4937)	(0 4937)	(0 3463)			
B/Gwari	Zaria	200	0 6741	0 3438	0 0318	0 3800+	–0 4120	0 9888	1 6362	One way short run integration
			(0 2312)	(0 2011)	(0 1020)	(0 1371)	(0 1391)			
B/Gwari	Ibadan	500	0 5766+	0 3513	0 0335	–0 0917	0 1358	0 9853	4 2460	One way short run integration
			(0 2135)	(0 2411)	(0 0441)	(0 0534)	(0 0467)			
B/Gwari	Kaduna	120	0 4890+	0 4480	–0 0302	–0 0195	0 1684	0 9864	2 9038	One way short run integration
			(0 2148)	(0 2477)	(0 0615)	(0 0718)	(0 0599)			
B/Gwari	Wushishi	122	0 7124	0 1843	0 2806	–0 3410+	0 2185	0 9841	2 0891	One way short run integration
			(0 2265)	(0 2620)	(0 1555)	(0 1512)	(0 1364)			
Minna	Wushishi	65	0 8119	–0 1440	0 0101	–0 0751	0 3819+	0 9869	2 1260	One way short run Integration
			(0 1917)	(0 1959)	(0 1302)	(0 1637)	(0 1722)			
Bida	Ilorin	280	1 1256	–0 3901	0 1545	–0 2983	0 3064+	0 9787	3 6736	One way short run integration
			(0 1925)	(0 2074)	(0 1437)	(0 1676)	(0 1436)			
Kaduna	Ilorin	455	0 8546	–0 2558	0 6113	–0 6364+	0 3499	0 9578	1 3429	One way short run integration
			(0 2104)	(0 2283)	(0 1812)	(0 2546)	(0 2182)			
Kaduna	Ibadan	620	0 9034	–0 3503	0 4521	–0 4327+	0 2489	0 9657	2 0878	Two way short run integration
			(0 1956)	(0 1871)	(0 1071)	(0 1666)	(0 1518)			
Ibadan	Kaduna	620	0 9272	–0 2366	0 9657	–0 8978+	0 3896	0 9712	1 0327	
			(0 1983)	(0 2292)	(0 2287)	(0 3500)	(0 2821)			

$p < 0\,01$ +$p < 0\,05$ Standard errors are in parentheses

Notes See Dittoh 1993 for the complete tomato market integration results See table 1 for other notes

There is also a need to eliminate some groups of market intermediaries in the vegetable trade Ways should be found to remove secondary wholesalers for example Assemblers and primary wholesalers could be assisted with credit facilities and management advice to integrate their businesses vertically by establishing strong bases in the urban centers That will make it possible for them to sell directly to retailers and consumers Many of the assemblers and primary wholesalers recognize the profitability of vertical integration of their businesses, but they lack the capital and the technical know-how

Related to the above is the need to encourage more marketers to be assemblers and primary wholesalers That will increase competition and will result in increased marketing efficiency to the benefit of producers, the marketers, and consumers Assemblage and primary wholesaling of vegetables requires considerable capital and adequate transportation The encouragement that is required is therefore well-planned credit and transportation arrangements Improvements in roads and other rural infrastructure in the producing areas will also enhance the assemblage of produce

The findings of this study support the assertion that vegetable marketing in Nigeria is a very risky business Because of the lack of integration marketers have to discount heavily for the high risks Assemblers and wholesalers of vegetables have been known to incur financial losses of over 100% at times There is the need therefore to institute an insurance scheme for vegetable marketers The scheme could be restricted initially to assemblers and primary wholesalers who have primary retail outlets in towns and cities That will further enhance the elimination of secondary wholesalers and other emergency marketers

Small-scale processing of vegetables does not currently exist in the producing areas It is however known that small-scale processing of peppers, tomatoes, and other vegetables is one of the ways of solving the lack of adequate market for vegetables

Table 3 Complete pepper market integration results

Market 1	Market 2	Approx distance (km)	P_{11}	P_{12}	P_{21}	P_{21}	P_{22}	T	R^2	IMC	Classification
Zaria	Ibadan	700	0 6251	0 0837	0 1504	–0 2698	0 1860	0 1760	0 9776	3 3608	Two way short run integration
			(0 1893)	(0 1702)	(0 0693)	(0 0899)	(0 0818)	(0 0969)			
Ibadan	Zaria	700	1 0277	–0 6104	1 1309+	–1 2647+	0 1152	0 2786	0 7996	0 8126	
			(0 1967)	(0 2123)	(0 5208)	(0 5724)	(0 4684)	(0 2780)			
Zaria	Kaduna	80	0 2839	0 3909	0 5679	–0 6175	0 3285	0 1416	0 9736	Infinity	
			(0 2059)	(0 2171)	(0 2947)	(0 3297)	(0 2260)	(0 0966)			
Kaduna	Zaria	80	0 8787	–0 3091+	0 2454	0 1769	–0 4227	0 1276+	0 9817	2 0788	One way short run integration
			(0 1428)	(0 1409)	(0 1269)	(0 1357)	(0 1241)	(0 0607)			
Zaria	Ilorin	535	0 5811	0 0704	0 4410	–0 5052+	0 2478	0 1612+	0 9784	1 1502	Two way short run integration
			(0 1996)	(0 1826)	(0 1523)	(0 2334)	(0 1854)	(0 0779)			
Ilorin	Zaria	535	0 9610	–0 2222	0 6058	–0 5785+	0 0536	0 1115	0 9494	1 6612	
			(0 2234)	(0 2208)	(0 2092)	(0 2456)	(0 2145)	(0 0967)			
Zaria	Minna	370	0 2965	0 1898	0 3365+	–0 1285	0 1460	0 1859	0 9770	Infinity	
			(0 2051)	(0 2100)	(0 1286)	(0 1595)	(0 1551)	(0 0634)			
Minna	Zaria	370	0 5454+	–0 0929	0 6816+	–0 0862	–0 3531	0 0393	0 9135	Infinity	
			(0 2001)	(0 2241)	(0 2605)	(0 3043)	(0 2951)	(0 1054)			
Zaria	Bida	470	0 5462+	0 1348	0 5053	–0 4991+	0 3202	0 1998	0 9812	1 0944	One way short run integration
			(0 2004)	(0 1760)	(0 1427)	(0 1839)	(0 1889)	(0 0554)			
Bida	Zaria	470	0 6555	–0 2572	0 6984	–0 2566	–0 1826	–0 1135	0 7996	Infinity	
			(0 2075)	(0 2294)	(0 1972)	(0 2657)	(0 2060)	(0 0780)			
Zaria	Wushishi	322	0 4091	0 1629	0 0527	–0 2331	0 2987	0 2864	0 9700	Infinity	
			(0 2040)	(0 1958)	(0 2629)	(0 4247)	(0 2889)	(0 0748)			
Wushishi	Zaria	322	1 2498	–0 5577+	0 0331	–0 0383	0 1726	0 0495	0 9180	Infinity	
			(0 2166)	(0 2033)	(0 1651)	(0 1751)	(0 1534)	(0 0751)			
Zaria	B/Gwari	200	0 3450+	–0 0775	0 6770	–0 6631	0 4378	0 2681	0 9879	0 5203	One way short run integration
			(0 1642)	(0 1478)	(0 1197)	(0 1757)	(0 1534)	(0 0485)			
B/Gwari	Zaria	200	0 8779	–0 4492+	0 8594	–0 1836	0 1390	–0 2190	0 9755	Infinity	
			(0 1730)	(0 1779)	(0 1519)	(0 1983)	(0 1650)	(0 0697)			
B/Gwari	Ibadan	500	1 1802	–0 3061	0 1698	–0 2088	0 1316	0 0476	0 9432	8 9656	Two way short run integration
			(0 2168)	(0 2463)	(0 0952)	(0 1215)	(0 0995)	(0 1066)			
Ibadan	B/Gwari	500	0 8693	–0 4939	0 7159	–1 6129	0 6143	0 4472	0 8210	0 5390	
			(0 1933)	(0 1851)	(0 4013)	(0 5835)	(0 5065)	(0 1990)			
B/Gwari	Kaduna	120	1 0114	–0 1676	0 2125	–0 3025	0 1499	0 1046	0 9355	Infinity	
			(0 2117)	(0 2547)	(0 3179)	(0 3914)	(0 2865)	(0 1187)			
Kaduna	B/Gwari	120	0 8787	–0 3590+	0 0896	–0 0951	–0 0555	0 2097	0 9726	Infinity	
			(0 0652)	(0 1716)	(0 1341)	(0 1931)	(0 1666)	(0 0652)			
B/Gwari	Ilorin	335	0 7606	–0 0075	0 5630	–0 3488	0 1435	–0 0065	0 9648	Infinity	
			(0 1836)	(0 1991)	(0 1540)	(0 2150)	(0 1819)	(0 0653)			
Ilorin	B/Gwari	335	0 6628	–0 0310	0 6526	–0 4422	–0 1608	0 1556	0 9562	Infinity	
			(0 2015)	(0 1984)	(0 1786)	(0 2444)	(0 2117)	(0 0625)			
B/Gwari	Minna	187	0 8339	–0 1224	0 1196	0 1650	0 0378	0 0507	0 9441	Infinity	
			(0 2105)	(0 2331)	(0 1578)	(0 1798)	(0 1838)	(0 0719)			
Minna	B/Gwari	187	0 5661+	–0 0440	0 2037	–0 1467	–0 1228	0 1850	0 8887	Infinity	
			(0 2076)	(0 2398)	(0 2688)	(0 3549)	(0 3049)	(0 8650)			
B/Gwari	Bida	247	0 9380	–0 0086	0 5793	–0 5146+	–0 0909	0 1287+	0 9611	1 8228	One way short run integration
			(0 2192)	(0 2592)	(0 1645)	(0 2192)	(0 2521)	(0 0526)			
Bida	B/Gwari	247	0 5748+	–0 0165	0 6049	–0 4378	–0 0579	–0 0418	0 8037	Infinity	
			(0 2187)	(0 2583)	(0 1717)	(0 2860)	(0 2646)	(0 0590)			
B/Gwari	Wushishi	122	0 0872	–0 1273	0 2244	–0 2667	0 4167	0 1354	0 9420	Infinity	
			(0 2200)	(0 2483)	(0 2864)	(0 4827)	(0 3019)	(0 0640)			
Wushishi	B/Gwari	122	1 2636	–0 5430+	0 1159	–0 1191	0 1482	0 0788	0 9180	Infinity	
			(0 2291)	(0 1952)	(0 1479)	(0 2035)	(0 1768)	(0 0475)			

Continued

Table 3 Continued

Market 1	Market 2	Approx distance (km)	P_{1t1}	P_{1t2}	P_{2t}	P_{2t1}	P_{2t2}	T	R^2	IMC	Classification
Wushishi	Ibadan	570	1 2230	–0 4655+	–0 0114	–0 0450	–0 0395	0 1775	0 9164	Infinity	
			(0 2279)	(0 1811)	(0 0654)	(0 0809)	(0 0696)	(0 0654)			
Ibadan	Wushishi	570	0 7715	–0 2907	–0 1159	–0 7853	–0 0250	0 3635	0 7687	Infinity	
			(0 2036)	(0 2148)	(0 6637)	(1 0769)	(0 6545)	(0 2269)			
Wushishi	Kaduna	242	1 1714	–0 4033+	–0 0526	–0 1977	0 1373	0 1568	0 9160	Infinity	
			(0 2206)	(0 1907)	(0 2183)	(0 2676)	(0 1920)	(0 0867)			
Kaduna	Wushishi	242	0 8854	–0 4105+	–0 0479	–0 0847	0 0265	0 2480	0 9719	Infinity	
			(0 1807)	(0 1642)	(0 1987)	(0 3135)	(0 1987)	(0 0718)			
Wushishi	Ilorin	405	1 1117	–0 3854+	–0 1030	–0 0742	0 2039	0 1583+	0 9195	Infinity	
			(0 2225)	(0 1768)	(0 1393)	(0 1865)	0 1465)	(0 0610)			
Ilorin	Wushishi	405	0 7200	–0 0040	–0 2255	0 1273	0 1691	0 2803	0 9309	Infinity	
			(0 2328)	(0 2258)	(0 3050)	(0 4747)	(0 2853)	(0 0844)			
Wushishi	Minna	65	1 2204	–0 3673	–0 0612	–0 0170	–0 0040	0 1339+	0 9108	Infinity	
			(0 2320)	(0 2209)	(0 1267)	(0 1399)	(0 1118)	(0 0623)			
Minna	Wushishi	65	0 4872+	–0 1406	–0 1640	0 6776	–0 0377	0 2620+	0 8979	Infinity	
			(0 2053)	(0 1808)	(0 3397)	(0 5459)	(0 3828)	(0 0974)			
Wushishi	Bida	125	1 2077	–0 3499	–0 0404	–0 2098	0 1653	0 1189	0 9185	Infinity	
			(0 2121)	(0 1803)	(0 1497)	(0 1621)	(0 1600)	(0 0402)			
Bida	Wushishi	125	0 4517	–0 0455	–0 0781	0 1873	0 2200	0 0844	0 7215	Infinity	
			(0 2138)	(0 2274)	(0 2896)	(0 4563)	(0 2666)	(0 0633)			
Bida	Ibadan	445	0 9969	–0 5165	0 2254	–0 3589+	0 2139	0 0137	0 7567	2 7877	Two way short run integration
			(0 2531)	(0 2796)	(0 1094)	(0 1422)	(0 1036)	(0 1018)			
Ibadan	Bida	445	0 9679	–0 4901	0 6917	–1 9807	0 5913	0 3910+	0 8846	0 4887	
			(0 1962)	(0 1692)	(0 3356)	(0 3983)	(0 5102)	(0 1587)			
Bida	Kaduna	390	0 5100+	0 0796	0 4023	–0 0494	–0 1327	–0 0404	0 7162	Infinity	
			(0 2093)	(0 2610)	(0 3380)	(0 3825)	(0 2601)	(0 1245)			
Kaduna	Bida	390	0 7407	–0 2602	0 1442	–0 0642	–0 3179+	0 2490	0 9788	2 3300	One way short run integration
			(0 1692)	(0 1469)	(0 1212)	(0 1399)	(0 1419)	(0 0537)			
Bida	Ilorin	280	0 5195+	–0 1303	0 6579	–0 4175	0 0968	–0 1172	0 8686	Infinity	
			(0 2106)	(0 2349)	(0 1421)	(0 2646)	(0 2249)	(0 0718)			
Ilorin	Bida	280	0 7404	–0 0453	0 7331	–0 5608+	–0 0199	0 2163*	0 9675	1 3203	One way short run integration
			(0 2502)	(0 2382)	(0 1584)	(0 2210)	(0 2495)	(0 0661)			
Bida	Minna	100	0 4646+	0 0097	0 2616	0 0438	–0 0455	–0 0295	0 7364	Infinity	
			(0 2064)	(0 2326)	(0 1596)	(0 1817)	(0 1461)	(0 0703)			
Minna	Bida	100	0 4912+	–0 0133	0 4000	–0 1982	–0 2884	0 2263	0 9026	Infinity	
			(0 2002)	(0 1811)	(0 2440)	(0 2788)	(0 2813)	(0 0734)			
Minna	Ibadan	545	0 5872	–0 0937	0 0594	–0 0775	0 1708	0 1061	0 8943	Infinity	
			(0 1923)	(0 1815)	(0 1084)	(0 1390)	(0 1187)	(0 1263)			
Ibadan	Minna	545	0 8172	–0 3939	0 2168	–0 2604	–0 1726	0 4009	0 7534	Infinity	
			(0 2059)	(0 2220)	(0 3958)	(0 4322)	(0 3470)	(0 2302)			
Minna	Kaduna	290	0 5842	–0 1341	0 4156	–0 3031	0 2885	0 0670	0 8928	Infinity	
			(0 2011)	(0 1941)	(0 3795)	(0 4695)	(0 3498)	(0 1401)			
Kaduna	Minna	290	0 8647	–0 3487	0 1193	–0 0741	–0 0556	0 2135*	0 9735	Infinity	
			(0 1786)	(0 1757)	(0 1089)	(0 1250)	(0 1044)	(0 0609)			
Minna	Ilorin	380	0 5411	–0 0485	0 2912	0 1804	–0 3407	0 0634	0 9006	Infinity	
			(0 1933)	(0 1825)	(0 2312)	(0 3279)	(0 2711)	(0 1090)			
Ilorin	Minna	380	0 6912	0 0277	0 2216	–0 1279	0 0169	0 2039+	0 9305	Infinity	
			(0 2492)	(0 2444)	(0 1759)	(0 1934)	(0 1594)	(0 0859)			
Ilorin	Ibadan	165	1 2512	–0 2984	0 3759	–0 3095+	0 2036	–0 0757	0 9571	6 1450	Two way short run integration
			(0 2486)	(0 2538)	(0 0946)	(0 1318)	(0 0947)	(0 1019)			
Ibadan	Ilorin	165	0 8318	–0 4427	1 0834	–2 1013	0 7144	0 4814	0 9140	0 3958	
			(0 1788)	(0 1501)	(0 2725)	(0 4270)	(0 4179)	(0 1435)			

Continued

Table 3 Continued

Market 1	Market 2	Approx distance (km)	P_{11}	P_{12}	P_{2t}	P_{2t1}	P_{2t2}	T	R^2	IMC	Classification
Ilorin	Kaduna	455	0 6312+	0 1458	0 2761	0 0390	–0 2887	0 2330	0 9342	Infinity	
			(0 2411)	(0 2485)	(0 3382)	(0 3859)	(0 2723)	(0 1266)			
Kaduna	Ilorin	455	0 7448	–0 2564	0 1020	0 0548	–0 2392	0 1959+	0 9772	Infinity	
			(0 1758)	(0 1609)	(0 1249)	(0 1665)	(0 1438)	(0 0716)			
Kaduna	Ibadan	620	0 7415	–0 1968	0 1042	0 0134	–0 0999	0 2125	0 9799	Infinity	
			(0 1830)	(0 1512)	(0 0506)	(0 0700)	(0 0606)	(0 0571)			
Ibadan	Kaduna	620	0 6245+	–0 1193	1 4967	–0 6521	–0 2073	–0 0346	0 7855	Infinity	
			(0 2312)	(0 2415)	(0 7260)	(0 8977)	(0 5923)	(0 2739)			

$p < 0\ 01$ $+p < 0\ 05$ Standard errors are in parentheses
Notes See table 1

during the peak production periods of February March and April Simple techniques such as dehydration can help to preserve vegetables for a considerable time (Ahmed 1992) Temporal and spatial price variations will be minimized if entrepreneurs can be encouraged to process vegetables on a small scale by for example, linking such entrepreneurs to buyers of such semi finished products within and outside the country

Finally specialization in the production of certain vegetables in specific locations in the country can enhance vegetable marketing efficiency The present trend toward specialization by vegetable producers can be enhanced if the government will institute effective extension services to help small scale irrigators improve their knowledge of irrigated agriculture Some consideration should also be given to the institution of agricultural marketing extension services Such extensionists have to be well trained in the principles and practice of agricultural marketing in all its ramifications

Literature Cited

Adegeye A J and S Dittoh 1986 Increasing cocoa production through effective marketing of cocoa spraying chemicals in Nigeria *Agricultural Administration* 22(2) 105 15

Ahmed M K 1992 Home gardens Paper presented at Training Workshop on Foodcrops Utilization and Nutrition organized by UNICEF (Nigeria) and IAR Ahmadu Bello University Zaria

Anthonio Q B O 1968 The marketing of staple foods in Nigeria A study of pricing efficiency Ph D thesis University of London

Anthonio Q B O 1973 Problem of marketing agricultural produce with special reference to foodstuffs in Nigeria In *Factors of agricultural growth in West Africa* ed I M Ofori 251 62 Institute of Statistical Social and Economic Research Legon University of Ghana

Berg E 1980 Reforming grain marketing systems in West Africa A case study of Mali In *Proceedings of the International Workshop on Socioeconomic Constraints to Development of Semi Arid Tropical Agriculture* 147 72 Hyderabad India ICRISAT

Blyn G 1973 Price series correlation as a measure of market integration *Indian Journal of Agricultural Economics* 28(2) 56-59

Bressler R G and R A King 1970 *Markets prices and international trade* New York John Wiley and Sons

Dahlgran R A and S C Blank 1992 Evaluating the integration of contiguous discontinuous markets *American Journal of Agricultural Economics* 74(2) 469-79

Dittoh S 1992 The economics of dry season vegetable production in Nigeria *Acta Horticulturae* 296 257 64

Dittoh S 1993 The marketing of dry season vegetable crops in Nigeria University of Ibadan Ibadan Nigeria Typescript

Eicher C K and D C Baker 1982 *Research on agricultural development in sub Saharan Africa A critical survey* MSU International Development Papers No 1 Department of Agricultural Economics East Lansing Michigan State University

Ejiga W O O 1977 Economic analysis of storage distribution and consumption of cowpeas in Northern Nigeria Ph D thesis Cornell University

Faminow M D and B L Benson 1990 Integration of spatial markets *American Journal of Agricultural Economics* 72(1) 49 62

Gilbert E H 1969 The marketing of staple foods in Northern Nigeria A case study of the staple food marketing systems serving Kano city Ph D thesis Stanford University

Godfrey 1978 Testing against general autoregressive and moving average errors models when the regressors include lagged dependent variables *Econometrica* 46 1293-1302

Harriss B 1979 There is method in my madness Or is it vice versa? Measuring agricultural market performance *Food Research Institute Studies* 17(2) 197-218

Hays H M 1975 *The marketing and storage of food grains in Northern Nigeria* Samaru Miscellaneous Paper No 5 IAR Zaria Nigeria Ahmadu Bello University

Hays H M and J H McCoy 1978 Food grain marketing in Northern Nigeria Spatial and temporal performance *The Journal of Development Studies* 14(2) 182 92

Heyten P H 1986 Testing market integration *Food Research Institute Studies* 20(1) 25-41

Ingawa S A 1983 Marketing of foodcrops and inputs The case of Funtua Agricultural Development Project in Kaduna State Nigeria Ph D thesis Michigan State University

Jones W O 1968 The structure of staple food marketing in Nigeria as revealed by price analysis *Food Research Institute Studies* 8(2) 95 123

Jones W O 1972 *Marketing staple foods in tropical Africa* Ithaca Cornell University Press

Miracle M P 1968 Market structure in commodity trade and capital accumulation in West Africa In *Markets and marketing in development economies* ed R Moyer and S Hollande 209-27 Homewood Illinois Irwin

Olayemi J K 1972 Improving marketing as a strategy for generating increased food production The Nigerian experience *West African Journal of Agricultural Economics* 1(1) 86-109

Ravallion M 1985 The performance of rice markets in Bangladesh during the 1974 famine *The Economic Journal* 92 15 29

Ravallion M 1986 Testing market integration *American Journal of Agricultural Economics* 68(4) 88-109

Thodey A R 1969 Analysis of staple food price behavior in Western Nigeria Ph D thesis University of Illinois

Wilcock D C 1978 *The political economy of grain marketing and storage in the Sahel* African Rural Economy Working Paper No 24 Department of Agricultural Economics East Lansing Michigan State University

Population Pressure, Land Use, and the Productivity of Agricultural Systems in the West African Savanna

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SUMMARY
The problem of resource degradation as farming systems evolve is receiving increasing attention in agricultural economics research With the elimination of the land frontier in many countries in sub-Saharan Africa, increases in agricultural production will have to come from more intensive use of land and other agricultural resources As land use is intensified fallow periods decline and crop cultivation spreads into marginal or ecologically fragile lands In the absence of appropriate resource management technologies, these practices inevitably lead to degradation of the resource base with important implications for soil productivity household food security, and rural poverty

Although economists have attempted to conceptualize these biophysical and socioeconomic relationships and identify the possible causes and consequences of the intensification process, there have been few attempts to quantify these relationships The present study attempts to redress this imbalance by developing a quantitative model of the intensification process using survey data from the northern guinea savanna of West Africa

The study argues that the severity of the problem posed by agricultural intensification and related environmental degradation depends largely on the factors that cause the system to intensify The validity of that argument rests on the hypothesis that the outcomes from the two major driving forces of the intensification process—increases in population density and improved market access—are farming systems that differ in resource bases, cultivation practices and constraints

The study examines the role of economic factors in explaining investments that enhance productivity (e g fertilizer application) and those that improve sustainability Linear programming is used to generate optimal farm plans in which the cropping pattern, levels of resource use and present value of net farm income are endogenously determined The model simulates the trajectory of different types of agricultural intensification when initial conditions change because of exogenous demographic, technological, and policy interventions It is concluded that there are substantial differences in farmer welfare, cropping patterns and the productivity of resources between a population-driven intensification and market-driven intensification

Analysis of agricultural systems in sub-Saharan Africa was, in the past based on assumptions of scarce labor and abundant land When population densities are low, capital inputs are scarce and technology is simple the predominant land management system is based on shifting cultivation (Binswanger and McIntire 1987) Farmers clear a plot of land, typically cultivate the plot for 1 to 3 years, and then abandon it to lie fallow for up to 25 years During the fallow

period there is forest or bush regrowth (Boserup 1965 Sanchez 1976 Pingali Bigot and Binswanger 1987) The groundcover protects the soil from erosion and controls noxious weeds The gradual accumulation of nutrients supplied by the decay of organic matter from secondary growth of natural vegetation regenerates soil fertility (Sanchez 1976 IITA 1992)

This traditional land management system which rotates cultivation periods with long fallow periods is stable biologically efficient and sustainable (Ruttan 1991 Spencer and Swift 1992) However there are currently few areas in sub Saharan Africa where fallow periods are long enough to fully regenerate soil fertility without tangible declines in crop productivity In many areas fallow periods have been shortened to the point that they are too brief to allow the soil to regenerate itself sufficiently to restore fertility (Spencer and Polson 1991 World Bank 1992)

The problem of degradation of the resource base as farming systems evolve is receiving increasing attention in agricultural economics research Economists have focused on farmer resource allocation decisions and the productivity and sustainability of agricultural systems under conditions of high land use intensity (Pingali Bigot and Binswanger 1987 Lele and Stone 1989 Smith et al n d) This focus is important because with the elimination of the land frontier in many sub Saharan countries increases in agricultural production will have to come from intensified use of land and greater use of other agricultural resources that increase the productivity of land and labor (IITA 1988)

Rapid growth of population and other demands on arable land strain the resource base in many parts of sub-Saharan Africa The breakdown of traditional land management practices has resulted in intensive crop production with significantly reduced fallow periods and the cultivation of marginal lands In the absence of sound soil management practices or the economic use of fertilizers and other additives declining fallow periods result in accelerated leaching of nutrients increased weed populations erosion and decreased moisture retention (Lal 1983 IITA 1992) As a result soil fertility declines adversely affecting crop yields labor productivity and returns from farming Soil productivity declines further with increased intensity of land use because of topsoil loss and the development of subsoil characteristics that are less favorable for root growth and development (Lal 1983) Thus degradation of the resource base has important implications for soil productivity household food security, and rural poverty

Research shows that when the opportunity cost of land is high, farmers have more incentives to invest in technologies that maintain soil productivity (Smith et al n d) On the other hand when the return to land is low farmers may not be able to invest in technologies that maintain soil productivity even though they may be aware of the negative impact of soil degradation on crop productivity (Barbier 1990) Thus the relationships between farm resources agronomic production systems and the investment behavior of farmers are important determinants of farm profitability as well as the long-run sustainability of agricultural production systems under different soil and land management practices

Although agricultural economists have attempted to conceptualize these biophysical and socioeconomic relationships and to identify the possible causes and consequences of the intensification process, there have been few attempts to quantify these relationships This study attempts to do so by developing a quantitative model of the intensification process using survey data from the northern guinea savanna of West Africa The study considers the role of economic factors in explaining farmers willingness and ability to make investments that enhance productivity (e g fertilizer application) and those that improve sustainability (e g land improvements)

Farm management surveys from Nigeria and Benin were used in linear programming models to generate optimal farm plans for two distinct farming systems These optimal farm plans are compared to test the hypothesis that there are significant differences in farmers resource levels cropping patterns and constraints in population-driven and market-driven intensification [1]

The coefficients generated from the two recent surveys are combined with an earlier survey in northern Nigeria to develop a dynamic model that

[1]See Smith et al [n d] for the main distinctions between population driven and market driven intensification

simulates the evolution of two distinct agricultural systems in the northern guinea savanna The model is hypothetical with primary concern on the relationship and trend among the variables of interest rather than on their absolute values In essence the model reduces to a test of the determinants of the intensification process

Comparative static equilibria are explored by changing model parameters and constraints to simulate the effect of various shocks on the system The model illustrates that exogenous changes in population, technology, and government policy result in different trajectories of the intensification process

A key premise of the study is that these exogenous changes have differential impacts on the farmers' resource bases and consequently on their resource allocation decisions The outcome of these decisions largely determines the farmers' abilities to undertake productivity-enhancing and sustainability investments that ensure rising per capita food production in both the short and long run

Research Questions and Study Objectives

This paper seeks to provide answers to such questions such as what are the economic responses of farmers as cultivable land is used more intensively? Do these responses differ when the driving force for higher land-use intensity is population pressure or improved market access, or both, supported by a favorable policy environment? What are the implications for maintaining long-term soil productivity in a population-driven and market-driven intensification of land use? These questions are interesting to economists for two main reasons First, agricultural intensification involves issues such as multiple cropping technology adoption, and increased activity in input and product markets that are central to the development of sustainable agricultural systems in most countries in the region Second, the lessons learned from understanding the process of intensification of land use are important for extrapolating research results to other environments with similar characteristics The objectives of the study are

- to present a comparative analysis that will test the differences in farmer welfare, cropping patterns, and the productivity of farmer resources in two areas of high land-use intensity in the northern guinea savanna of West Africa
- to generate some stylized facts on the behavior of land and labor productivity, intensity of purchased input use, and technology adoption
- to simulate the impact of various policy options on farmers' welfare, resource use, and productivity
- to discuss the implications of the results for policy analysis and technology development in the northern guinea savanna and in other agricultural systems that have a similar ecological base

To understand the intensification process, it is important to gain insights into the decision making processes of agricultural households, particularly with respect to allocation of inputs to production and investment It is also important to understand farmers' responses to policy interventions in relation to the socioeconomic, technical, and institutional constraints within which farmers operate At the microeconomic level, the tradeoffs and possible outcomes of household decision making depend on a number of interrelated factors Among these are changes in the level of the household s real income, substitution possibilities among competing crops technological possibilities, the efficiency of marketing operations, and the possibilities for investing in farm equipment and land improvement The relations between these factors are complex Yet, a thorough understanding of these linkages is important because the consequences and relative merit of alternative policies critically depend on the household's response to policy intervention

Studies of agricultural intensification in sub-Saharan Africa provide evidence of increased agricultural productivity, increased specialization in production, and increased on-farm employment possibilities (von Braun, Kennedy, and Bouis 1990, Smith et al n d) However, the order of magnitude of these changes and their effects on farm income, crop mix, input use, technology adoption, and land-improving investments are not clear Because these studies are mostly conjectural, they do not imply causation The present study combines biophysical,

demographic and economic relationships to shed light on the complex linkages involved in household decision making as land use intensifies

Agro-ecological Background

The northern guinea savanna of West Africa is characterized by a savanna vegetation dominated by thick barked trees and tall grasses Significant declines in crop yield occur as land use is intensified because crops and noxious grassy weeds compete for nutrients and sunlight High levels of weed infestation are usually the first symptom of soil resource degradation

The distribution of rainfall is unimodal with about 900 to 1 200 millimeters annually and a growing period of 140 to 170 days There is a distinct wet season of about 4 to 6 months and a dry season of 4 to 5 months when rainfall levels go below 25 millimeters per month Rains start in May peak in August and end in September-October There are wide variations in the total amount of annual rainfall and its distribution In an area where agriculture is entirely rainfed there is great concern about irregularities in the beginning and end of the rains A brief dry period usually follows the onset of the first rains but there is considerable uncertainty about the length of this dry spell Farmers who plant immediately after the first rains run the risk that an unusually long dry spell will cause crop failure because of the resulting moisture stress The total amount of rainfall and the length of the wet season decreases as one moves from south to north (Kowal and Knabe 1972) and there is a corresponding decrease in the length of the growing period In some areas, high intensity rainfall causes severe soil erosion and waterlogging, which may inhibit crop growth

Mean daily temperatures usually are above 18°C during the growing period temperature is not a limiting factor for crop growth because the optimum temperature range for most crops grown in the zone is 22° to 30°C (IITA 1988)

The zone is characterized by highly weathered ferruginous tropical soils that exhibit wide variations depending on the parent material Soils are generally shallow highly laterized and low in available phosphorus and nitrogen They have moderate pH levels that indicate slight or moderate acidity problems The topsoil is mostly sandy with low organic matter and base exchange capacity Subsoils are easily compacted because of the ac cumulation of kaolinitic clay Soils are poorly buff ered with low cation exchange capacity and soil organic matter is usually less than 3% of organic carbon (Ogunbile Olukosi and Elemo 1992) The physical status of the soil is poor—there are wide variations in moisture-retaining capacity due to differences in the structural composition of the soil Available plant nutrients tend to be low because of leaching high soil runoff and erosion Large amounts of nitrogen and sulphur are lost from the soil through removal of crop residues from the fields and through burning

Soils in this zone like most tropical soils, are susceptible to deficiencies in previously available micronutrients or macronutrients (such as potas sium) when they are continuously cultivated Crops grown in this ecology usually respond well to fertil izer application Thus there is potential for sustaining yields under continuous cultivation with economic use of fertilizers and other intensive soil management practices

The long dry season deters the build-up of a formidable pest complex except on groundnut cowpea and cotton Striga a parasitic weed, is however a serious problem in many low input farming systems

Characteristics of the Farming Systems in the Study Area

In northern Nigeria the dominant crops on upland fields are maize sorghum, cotton cowpea, and groundnut Millet has declined in importance since the introduction of higher yielding maize varieties In the uplands in Boukoumbe in Benin, sorghum, *fonio* (*Digitaria exilis*), millet cowpea, bambara nut and groundnut are the major crops The lowlands in northern Benin are almost exclusively allocated to rice cultivation In northern Nigeria, the lowlands overwhelmingly support commercial crops like sugarcane and vegetables

Both in Nigeria and Benin, farming systems are dominated by cereals but legumes are also important In northern Nigeria cereals occupied 75% of the total cultivated area in the sample while legumes accounted for only 11% Of the cereals, sor-

ghum and maize accounted for about 33 % of the total cultivated area Sorghum, the traditional staple, occupied a slightly higher area than maize In Boukoumbe, cereals occupied 64% of the total cultivated area in the sample Legumes were however more important in Boukoumbe than in northern Nigeria, occupying 26% of total cultivated area Among the cereals in Boukoumbe, fonio accounted for 33% of total cultivated area, while sorghum accounted for 23%

Intercropping and monocropping are practiced in both systems, although intercropping practices are favored by most farmers because they reduce risk and maximize farm revenues (Norman, Pryor, and Gibbs 1979) The most common intercrop in the sample villages in northern Nigeria is maize/sorghum Other important combinations in this system are maize/cotton, maize/cowpea, and sorghum/groundnut In northern Benin, sorghum/cowpea intercrop dominates the farming system This combination is followed by sorghum/millet and other three-crop mixtures usually involving a combination with sorghum and cowpea Fonio and legumes like bambara nut and groundnut are usually grown as sole crops Fonio, a hardy crop that survives on badly eroded soils, is often grown as a sole crop In an area where soils are degraded and there is little use of external inputs, legumes are important in farmers soil fertility maintenance strategies Legumes are also grown as a sole crop in fields that have previously been planted to cereals because the parasitic weed striga does not reproduce on legumes as it does on the more susceptible cereal crops like sorghum

Crop yields in northern Benin are far lower than those in northern Nigeria

	Yield (kg/ha)	
	Benin	*Nigeria*
sorghum	438	1 545
maize	na	2 622
millet	312	501
cowpea	38	325
groundnut	385	na
bambara nut	169	na
fonio	134	na
cotton	na	764

In both areas, fallow periods have been reduced to the point where they are insufficient to restore soil fertility, or they have been eliminated The effects of degraded soils on crop yields are, however, more pronounced in Boukoumbe because farmers use no fertilizer or other external inputs that enhance soil fertility In northern Nigeria, farmers are more commercially oriented and most have more cash resources to hire labor to supplement family labor By overcoming household labor constraints, the farmer is able to complete cultural operations on time or do them more effectively In contrast in Boukoumbe, the subsistence orientation of production and a thin labor supply limit farm labor to that provided by the family, though reciprocal labor groups may be organized at peak periods Severe labor constraints imply that most operations cannot be done on time, or when they are done, they are not done effectively For example in northern Nigeria, the yield loss due to weeds is minimal because farmers hire sufficient labor to weed the fields three times in one cultivation season In Boukoumbe, on the other hand, the majority of farmers weed their fields only twice because they are strapped for labor As a result, increased weed-crop competition has a negative impact on crop yield Farmers' control of striga also illustrates how differences in resource use can affect crop performance In contrast with Boukoumbe, yield loss in northern Nigeria due to striga is minimal because cereal fields are weeded thoroughly and on time and the high level of fertilizer applied acts as a control mechanism (G K Weber personal communication) These differences in crop management practices are reflected in differences in the yield losses due to pest, diseases and weeds

Livestock, especially small ruminants, play a significant role in both systems Goats are the predominant type of small ruminant held by farm households in both samples Poultry is very important in Boukoumbe In northern Nigeria, the mean household holding is five goats while the mean holding in Boukoumbe is four In the more food-insecure Boukoumbe sample, the sale of poultry and small ruminants was ranked as the most important source of cash income by 56% of households, while crop sale was ranked as the most important source by 23% of the households In contrast all households in the northern Nigeria sample ranked crop sale as the most important source of household income In Benin income from the sale of poultry and small ruminants is used to purchase grain for household consumption thereby smooth-

ing grain consumption in the face of production shortfalls In northern Nigeria livestock holdings are less important as a means for ensuring short-term availability of food supplies More often they are an integral part of the household s asset holding and are liquidated primarily to purchase fertilizer or to meet household cash expenses other than purchasing grain The evidence from both areas therefore highlights the importance of livestock holdings in meeting short term consumption needs and providing capital to purchase farm inputs

Analytical Methods

In 1991 and 1992 farm management information was collected in five villages in Nigeria and three villages in Benin by the author and other researchers at the International Institute of Tropical Agriculture These surveys provided data on farm-family characteristics farm size input use cropping patterns crop yields cropping calendars and input output prices The data was used to develop a composite model that utilizes comparative static solutions to simulate the evolution of two agricultural systems in the northern guinea savanna agro-ecological zone Activities are specified in the model for crop production crop sale fertilizer purchases and labor hiring Constraints are imposed on land labor and working capital

On-farm experimental results and data from secondary sources were used to adjust model parameters and constraints to incorporate the following in some model runs

- population increase
- public investments in rural infrastructure that reduces the marketing margin
- introduction of new maize varieties at two levels of fertilizer application

The analytical model

The composite model tests the hypothesis that the trajectories of population-driven intensification and market driven intensification diverge, resulting in farming systems that have very different resource bases cropping patterns and likely constraints The model is based on the premise that the land frontier has been reached and that the farming system can therefore be characterized as a permanent cultivation system with R a measure of land-use intensity,[2] greater than 70 (Ruthenberg 1980) In the initial period R has a value of 75, implying that three quarters of the land is under cultivation The hypothesis is that this period represents an early stage of population-driven intensification In this stage the farming system can evolve along either a population-driven intensification path or a market-driven intensification path depending on the exogenous shocks that cause the initial conditions to change An intensive farm management survey by David Norman and colleagues in three villages in the Zaria area of northern Nigeria in the late 1960s (Norman 1967a 1967b 1972a, 1977b) provides the data for the computation of initial-period coefficients These villages are in the same agro-ecological zone and latitude as the sample villages in the more recent surveys They also exhibited characteristics that are consistent with the stylized facts of an early phase of population-driven intensification

Activities developed from the recent northern Nigeria and Boukoumbe surveys are added to the base-year model to simulate the evolution of the two farming systems, with their differing resource availabilities, costs, and price environments Both hypothetical and realistic crop production alternatives are included in the model to allow it to determine representative farmers resource allocation decisions over time, considering their resource constraints Thus the model reveals the trends and relationships in farmers' decision making when there are variations in input supplies and technological options over time By concentrating on trends and relationships rather than on the absolute model values, the hypothetical model narrows down to a test of the determinants of the intensification process and of the differences in the consequences of population-driven and market-driven intensification

[2] Ruthenberg s R value gives a measure of the intensity of land use based on the relationship between the length of the cultivation and fallow period It is measured by $R = (C / C + F) \times 100$ where C is the length of the cultivation period and F is the length of the fallow period

Model scenarios

The different model scenarios are defined to correspond to distinct phases in the intensification process Because interest is on the dynamics of the intensification process when the land frontier has been reached, all model time periods reflect conditions where the length of cultivation period is less than the length of the fallow period

All constraints in the initial period apply in all the model runs Purchase activities however allow for the expansion of the initial farm resource base through the incorporation of purchase activities Reductions in resource endowments are modeled through the manipulation of the physical resource constraints over time For example population pressure leads to a reduction in the land-man ratio that is reflected in a reduction in the coefficient of the land constraint in each time period

As mentioned earlier, the study seeks to test the hypothesis that the model results will diverge considerably, depending on the exogenous changes that impact on the system In the market-driven intensification scenarios, increasing population densities, reflected in a reduction in the available cultivable land, are juxtaposed with public investments in rural infrastructure, reflected in lower marketing margins, technical progress that results in an improved maize variety, an effective extension system that leads to widespread adoption of new technologies and improved farm practices, and a subsidy that encourages adoption of fertilizer technology[3] In contrast, the only exogenous change that influences intensification of land use in the population-driven scenario is increased population densities This therefore reduces to a test of Boserup s original hypothesis (Boserup 1965)

The nature of the data does not permit precise determination of the relationship between intensification of land use and crop yields However based on anecdotal evidence, it is assumed that crop yields decline as increasing population pressures lead to a breakdown in the traditional land management system that maintained soil fertility Yield declines are more acute in the population-driven scenario because there is no use of fertilizer or other external inputs to maintain soil fertility In the market-driven intensification case crop yields are assumed to be nondecreasing once there is widespread adoption of fertilizer technology because of the residual effect of fertilizer on soil fertility

Four model scenarios are defined according to this criteria

- Model A is the initial or base-period run that represents an early phase of the intensification process *R* has a value of 75 Production conditions during this period are similar to those found by Norman, Pryor and Gibbs (1979) in the three villages they studied in northern Nigeria in the late 1960s
- Model B In model B (and all other subsequent model runs), population increase is reflected in a 10% decrease in the coefficient of land constraint in both population-driven and market-driven intensification In addition public goods investment in infrastructure in the market-driven intensification case is introduced into the model via reduced margins for marketing crops
- Crop production activities representing the adoption of new maize varieties are included in population-driven and market-driven intensification in Model C These activities are introduced at both high and low rates of fertilizer application to allow for the partial adoption of maize technology packages initially
- In Model D, there is complete adoption of the improved maize technology package The farm family s resource base is expanded to reflect higher working capital requirements arising from the adoption of the new technology

Specification of the linear programming model

As with all models, the structure of the static model comprised the objective function a set of activities, a set of constraints resource endowments or right-hand-side values and non-negativity constraints A basic premise of the model is that the representative farmer seeks to maximize net farm income subject to constraints imposed by the availability of resources In matrix notation, the basic

[3]This case is analogous to Lele and Stone s (1989) policy driven intensification where public sector intervention provides a catalyst for the intensification of production

linear programming model for a single period is given by

$$\begin{aligned} \max \quad & z'X \\ s.t. \quad & AX \le B \\ & y'X + X = 0 \\ & X, X, y \ge 0 \end{aligned}$$

where

X is an $n \times 1$ vector of crop activity levels
X is an $n \times 1$ vector of crop sales activities
B is an $n \times 1$ vector of the farmer's resource endowments or availabilities
A is an $n \times n$ matrix of an input output coefficient whose individual element a_{ij} represents the amount of the ith resource used to produce one unit of the jth activity
z is an $n \times 1$ vector of crop sales prices
y is an $n \times 1$ vector of crop yield levels

Model activities are specified considering both the socioeconomic and biophysical conditions under which farmers operate Five basic types of activities are included in the model crop production activities labor activities input purchase activities marketing activities and transfer activities Constraints are imposed on working capital and the physical resources land and labor Output allocation and accounting constraints are imposed to ensure consistency or balance among transfer activities in the model

Model Results

The major concern of this paper is to explore optimal farm plans to evaluate the differences in farmer welfare and constraints and the potential for technology adoption In the base-year scenario, population pressure is minimal hence there is still access to land even though it is not good quality land Land use in this scenario, measured by Ruthenberg's land use intensity factor, is 75 This implies that three quarters of the land available is under cultivation and the rest under fallow at any time during the cultivation period

The representative household in the base period uses traditional technology and no fertilizer or improved crop varieties The farm plan is dominated by low-valued cereals like millet and sorghum although groundnut a cash crop, also is prominent Under these conditions of declining soil fertility due to the pressures on the resource base, legumes that enhance soil fertility are an important component in the farmer's soil fertility management strategy

Public investments in rural infrastructure are introduced in the market-driven scenario in model B These investments reduce marketing margins by lowering the transaction costs of marketing Consequently, the farmgate price of crop output rises, input marketing costs decline, and real farm incomes grow (Binswanger 1989) With a 25% reduction in the marketing margin in market-driven intensification, farmgate prices increase correspondingly The representative farmer still allocates a substantial amount of land to millet-based activities However with the increased commercialization induced by the improved market access farmers allocate 8% more land to groundnut the major cash crop Net farm income increases by a mere 3% over the base year returns to labor increase by 14%, and the returns to land remain unchanged The fact that land productivity does not change with improved market access underscores the point that while public investments in rural infrastructure are necessary they are not sufficient to propel an agricultural system along a market-driven intensification scenario that has the potential of substantially increasing crop productivity and improving farmer welfare

In the population-driven intensification scenario, the only change in model B is increased population density, which reduces land-man ratios The cropping pattern remains largely unchanged except that some land is shifted from the sole groundnut to an intercropping mixture with groundnut With the increasing pressure on land farmers shift resources from commercial activities to production of food grain for household consumption Such behavior is typical of cases where poor market access causes food markets to fail In such cases households will respond to population pressure by producing most of their subsistence needs Net farm revenue declines by 43%, reflecting the increased move toward subsistence and labor and land productivity decline by 25% and 38%, respectively

Improved maize varieties are introduced into the model at two rates of fertilizer application The hypothesis here is that farmers adopt technological packages sequentially In the initial stages when

they are not familiar with the technology and are strapped for cash, they will tend to adopt components of improved technology packages that guarantee them a marginal increase over their current practice (Byerlee and de Polanco 1986) In the optimal farm plan, land is allocated from the lower valued millet/sorghum enterprises to the maize and maize/sorghum enterprises with the improved technological package The model results confirm that farmers indeed adopt technological packages sequentially In this case the representative farmer allocates about twice as much land to the enterprise with the lower fertilizer rates in both sole maize and maize/sorghum enterprises, even though the yields at higher levels of fertilization are substantially higher This situation changes in subsequent model runs when revenue from increased crop sales relaxes the cash constraint and the farmer becomes more familiar with the improved technology package

Farmer welfare and the productivity of farm resources improve substantially with the adoption of improved technology In model C, when the improved technological package is added to model B, the farm plan shows three-fold increases in net farm income and returns to land and labor This result confirms the hypothesis that improved market access, when complemented with improved technology that is widely acceptable, can lead to perceptible increases in farmer welfare and resource productivity especially land and labor productivity

As population pressure increases, land is taken out of the two-crop millet/sorghum activity and put into the three-crop millet/sorghum/cowpea activity Another legume activity, groundnut/bambara nut enters the optimal farm plan The farmer's optimal farm plan verifies the hypothesis that as traditional land management systems collapse and there is little use of external sources to maintain soil fertility, farmers increasingly turn to legumes, which do well when soil fertility is low and help to maintain soil fertility The activities with improved maize varieties enter the optimal farm plan in model C, but are allocated substantially less land than in the market-driven scenario In this period there is still some good quality land available, allowing maize to do well without large amounts of fertilizer The adoption of the improved technology doubles net revenue and the productivity of land and labor

In subsequent model runs, cash from crop sales, especially maize, provides funds that can be used to purchase fertilizer and hire labor in subsequent periods As land supply becomes more inelastic, farmers allocate more land to those enterprises with the higher yielding maize varieties As the farmer becomes accustomed to the improved technology, farmer welfare represented by net farm revenues continues to increase Labor productivity increases, but at a declining rate, while land productivity increases at an increasing rate This implies that with these biological and chemical technologies, the bulk of the improvement in farmer welfare will have to come from increases in land productivity

In the population-driven scenario farmers respond to the population pressure by taking land out of the high-input maize activities and allocating it to traditional food crops and legumes In this and subsequent runs, the activities with the improved maize varieties drop out of the optimal farm plan as population pressure leads to an intensification of land use In contrast with farmers in the market-driven scenario who intensify land use by increasing cultivation of maize, the poor market access of farmers in the population-driven scenario results in low crop sales that aggravate their cash constraint Farmers do not have the funds needed to purchase fertilizer or hire labor to undertake the high-input activities Consequently poor market access and lack of sustained adoption of improved technology reduce farmer welfare and harm land and labor productivity

Policy Simulations

The optimal farm plans can also be used for policy simulations In the first run, the question was, what would have happened to the intensification process and the adoption of technological packages in particular, if there had not been a generous subsidy on fertilizer? This question is of interest to both policy makers and researchers because of its implications for future technology developments, the extrapolation of research results to areas that have similar agro-ecological characteristics but a different policy environment, and

the consequences of removing the subsidy to ease the fiscal cost on the government

When Model C was run without the fertilizer subsidy the direct consequence was that land was taken out of the fertilizer-intensive maize activities and allocated to millet/sorghum and legumes which use little fertilizer Farmers shifted half as much land from all enterprises with maize to sor ghum/millet enterprises and groundnut in the new farm plan The results indicate that farmers would have still adopted the improved varieties but at a far slower rate than with the subsidy This is not surprising because the yields from the technological package of improved crop varieties and fertil izer significantly exceeded yields of the traditional varieties Given the farmer s food security and income-earning strategy the opportunity cost of the farmer s scarce resources is highest in the maize activities even without the subsidy

Without the fertilizer subsidy farmers allocate more land to legume enterprises than when the subsidy is in place This implies that farmers will rely on legumes to maintain soil fertility when demographic and economic pressures break down the traditional land management systems that maintain soil fertility This finding has important implications for the integration of sustainability perspectives in agricultural research and development Agronomic methods of soil fertility management like the incorporation of legumes into farm ing systems are often thought to be more desirable for the sustainability of farming systems than the use of large quantities of fertilizer which can lead to potential problems with soil acidification and reduction in soil organic matter (COMBS 1991) Governments therefore have to be consistent with fertilizer pricing policies and set subsidies at realistic levels—if they decide to give subsidies—so that resource management can compete as a viable soil fertility maintenance alternative

The second policy run looks at the effect of increased maize prices What would have happened if the increased production of maize had caused maize prices to drop by 10%? The model results show that a farmer would have continued to grow maize The decline in the price of maize is offset by an increase in maize yield so that the relative posi tion of maize in the farmer s optimal farm plan is still favorable It would take very large price swings to cause the opportunity cost of the farmer s resources to yield a better return in some activity that does not include maize

In this simulation infrastructure variables are introduced into a late phase of population driven intensification via a reduction in crop marketing margins The results indicate that the optimal farm plan did not change much Low-valued cereals and legumes are still prominent while the improved varieties are not adopted This result suggests that when agricultural systems have been declining long term, only a sustained policy intervention that provides appropriate incentives together with affordable and useful improved technologies can shift the system into a market-driven intensification path with increased land and labor productivity which in turn will improve farmer welfare

Conclusions

This study determined that population increase and improved market access broadly defined to encompass access to improved technology and a favorable policy environment, are the two major driving forces of agricultural intensification The results show that these two determinants have different consequences for farmers welfare, cropping patterns, intensity of purchased input use and productivity of farm resources This result contrasts with findings by Pingali Bigot, and Binswanger (1987) that there are no differences in the consequences of population-driven and market-driven intensification

The study also showed that public investments in rural infrastructure are necessary but not sufficient conditions for moving a system along a market driven path It takes sustained development of improved technologies that are both appropriate and affordable and a favorable policy environment to provide sufficient incentives for farmers to adopt these improved technologies

These results have several implications for technology development and policy In population-driven intensification areas household food security is a major concern because of the low crop yields Technology development efforts must concentrate on raising crop yields In this respect at tention needs to be given to cropping and resource management systems that permit the improvement

of soil fertility without necessarily sacrificing crop yields

On the other hand, household food security is not a major problem in market-driven intensification areas because high yields in both food and cash crops and well-developed food markets ensure that household food needs are met through either crop production or food purchases The major concern in these areas is to attain a modest increase in crop yields or sustain yields at their current levels While high levels of fertilizer use reduce the effect of chemical deterioration of the soils, there are potential problems with the physical deterioration of soils due to a lack of groundcover Such degradation threatens the long-run productivity of soils

There are also important implications for the types of technologies that are likely to be adoptable in population-driven and market-driven agricultural systems In population-driven intensification, farmers have limited cash resources so they are unlikely to adopt technologies that require high levels of purchased inputs Technologies that are likely to be adopted are those that will permit modest yield increases without large amounts of external inputs For instance the development of striga-resistant sorghum varieties will significantly reduce sorghum yield loss in the population-driven intensification areas that are dominated by cereals In the market-driven intensification areas farmers will adopt technologies that require external inputs if they are profitable The major concern should therefore be the affordability and appropriateness of improved technologies rather than the intensity of purchased input use In both population-driven and market-driven intensification, farmers can get impressive yield gains from improved crop management practices with little or no external inputs

The study showed how the presence or absence of a favorable policy environment can lead to very different outcomes There is need for sustained policy and institutional support in the development of infrastructure, improved technology, extension, and credit and marketing facilities to provide sufficient incentives for agricultural activities While agricultural activities are profitable in the market-driven intensification areas, farmers poor access to credit facilities often limits their ability to undertake productivity-enhancing and sustainability investments In the population-driven intensification areas, policy intervention is needed to improve the attractiveness of agriculture and provide incentives for farmers to adopt improved technologies

Literature Cited

Barbier E B 1990 The farm level economics of soil conservation The uplands of Java *Land Economics* 66(2) 199 211

Binswanger, H 1989 The policy response of agriculture In *Proceedings of the World Bank Annual Conference on Development Economics* Washington D C World Bank

Binswanger H and J McIntire 1987 Behavioral and material determinants of production relations in land-abundant tropical Africa *Economic Development and Cultural Change* 36(1) 73 99

Boserup E 1965 *Conditions of agricultural growth* Chicago Aldine Publishing

Byerlee D and E de Polanco 1986 Farmers step wise adoption and technological package *American Journal of Agricultural Economics* 68(3) 519-27

COMBS (Collaborative Group on Maize Based System Research) 1991 Soil fertility improvement and weed suppression through legume based technologies Collaborative Paper 1 Ibadan WAFSRN/IITA

IITA (International Institute of Tropical Agriculture) 1988 *Strategic plan 1989 2000* Ibadan

IITA 1992 *Sustainable food production in sub Saharan Africa* Ibadan

Kowal, J N and D T Knabe 1972 *An agroclimatological atlas of the northern states of Nigeria* Zaria Nigeria Ahmadu Bello University

Lal R 1983 Erosion caused productivity decline in soils of the humid tropics *Soil Taxonomy News* no 5 4-11

Lele U and S W Stone 1989 *Population pressure the environment and agricultural intensification Variations of the Boserup hypothesis* MADIA Discussion Paper 4 Washington D C World Bank

Norman D W 1967a An economic study of three Zaria provinces villages Part 1 Samaru Misc Paper 19 Zaria Nigeria Ahmadu Bello University

Norman D W 1967b An economic study of three Zaria provinces villages Part 2 Samaru Misc Paper 23 Zaria Nigeria Ahmadu Bello University

Norman D W 1972a An economic study of three Zaria provinces villages Part 3 vol 1 Samaru Misc Paper 37 Zaria Nigeria Ahmadu Bello University

Norman D W 1972b An economic study of three Zaria provinces villages Part 3 vol 2 Samaru

Misc Paper 38 Zaria Nigeria Ahmadu Bello University

Norman D W D H Pryor and C J N Gibbs 1979 *Technical change and the small farmer in Hausaland Northern Nigeria* African Rural Economy Paper 21 East Lansing Michigan State University

Ogunbile A J Olukosi and K Elemo 1992 Characteristics of target zone and technology adoption for the northern guinea zone of Nigeria In *Characterization of target zones and technological adaptation for on farm testing of leguminous species* ed G K Weber J Smith and J O Olukosi Ibadan WAFSRN/IITA

Pingali P Y Bigot and H P Binswanger 1987 *Agricultural mechanization and the evolution of farming systems in sub Saharan Africa* Baltimore John Hopkins University Press

Robinson W and W Schutjer 1984 Agricultural development and demographic change A generalization of the Boserup model *Economic Development and Cultural Change* 32(2) 355 66

Ruthenberg H 1980 *Farming systems in the tropics* London Clarendon Press

Ruttan V W 1991 Sustainable growth in agricultural production Poetry policy and science In *Agricultural sustainability growth and poverty alleviation Issues and policies* ed S A Vosti T Reardon and W von Urff Feldafing Germany DSE

Sanchez P A 1976 Properties and management of soils in the tropics New York Wiley

Smith J A D Barau A Goldman and J H Mareck [n d] *The role of technology in agricultural intensification The evolution of maize in the northern guinea savanna of Nigeria* Ibadan International Institute of Tropical Agriculture

Spencer D S C and M J Swift 1992 Sustainable agriculture Definition and measurement In *Biological nitrogen fixation and sustainability of tropical agriculture* ed K Molungoy M Gueye and D S C Spencer New York Wiley

Spencer D S C and R A Polson 1991 Agricultural growth and sustainability Conditions for their compatibility in the humid and sub humid tropics of Africa In *Agricultural sustainability growth and poverty alleviation Issues and policies* ed S A Vosti T Reardon and W von Urff Feldafing Germany DSE

Von Braun J E Kennedy and H Bouis 1990 Commercialization of smallholder Agriculture Policy requirements for the malnourished poor *Food Policy* 36(1) 82 5

World Bank 1992 *World development report* Washington D C

Land Tenancy and Exploitation of Palm Forest Resources in Nigeria

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SUMMARY
Nigeria is well endowed with palm forests, which are economically important for several communities that depend on forest resources for their livelihood But pressures on the palm forests are building up in several places as a result of increased commercialization This study examined traditional management practices and the profitability of the associated production enterprises

The palm forests are exploited for two main products Oil palm fruits are harvested and processed into palm oil and raphia palms are tapped to obtain palm wine, which may be further processed into a local gin known as *ogogoro* In Ondo State where the study was conducted the palm oil producers were able to produce an average of 2,931 liters of palm oil from the 4,530 fresh fruit bunches harvested in 1991 Also in the Ilaje and Apoi zones of the state where the tappers produced an average of 29,835 and 24,980 liters of palm wine about 2 242 and 2,027 liters of the local gin were obtained in the two zones respectively Indeed the enterprises were found to be profitable Operating profit in palm oil production exceeded that of palm wine by ₦1,293 (or 15%), and net income was higher by ₦2,285 (or 36%)

Exploitation of the palm forest resources is largely in the hands of migrants who acquire use rights through the payment of access fees and rents In 1991, the access fee for oil palm harvesting was ₦40 while rent was ₦150 per year In the raphia palm belt, the access fee was ₦10 while rent averaged ₦237 These rents appear to be moderate and are not subjected to frequent changes This has been a type of incentive for the resource users to stay in business

Because of the importance of the palm forests as a source of income and the difficulties being experienced in some areas, some communities have adopted management practices to regulate the behavior of users and to prevent over-exploitation These practices include imposition of a ban on the felling of raphia palms, prohibition of tapping of immature palms a closed season in the oil palm groves, and restriction on the number of fruit bunches harvested daily Owing to the prevailing regime of common property and the profitability of the enterprises, it has not been difficult to enforce compliance with the management rules Other factors that have favorably influenced the adoption of management practices include the common belief system of tenant harvesters, the cohesive social relations and their homogeneity culturally and linguistically

In situations where conflicts have arisen over the use and ownership of the palm forests, it has been possible to resolve them through negotiation mediation, and arbitration rather than adjudication The non-adjudicatory procedures have been preferred because of speed, low cost easy access and their reconciliatory tendencies

In view of the foregoing, government intervention in the control of access to the palm forests and their management, as some analysts have urged seems unwarranted in the study area Because there is a resilient regulatory mechanism what remains for the government to do is to examine the characteristics of the local institutions to determine how to strengthen and formalize them and encourage their adoption in other palm forest belts in the country In all the relevant ecological zones it will be necessary for the government to strengthen existing local management systems by (i) helping to define territorial boundaries where they are currently nonexistent or in dispute (ii) recognizing and strengthening tradi tional authorities involved in palm forest resource management (iii) creating awareness about community participation in palm forest resource management, and (iv) providing technical guidance for communities wishing to intensify management

Land tenancy is an important traditional institutional framework for the management of palm forest resources in Nigeria Land tenancy means the accepted local rules rights, practices, and duties that regulate access to and exploitation of the palm forest land Official regulation of the exploitation of palm forest resources is difficult to achieve owing to the scattered nature of the resource base and associated economic activities In addition some communities consider official inter vention an unnecessary encroachment on their environmental capital and source of wealth

As a possible alternative to official regulation, traditional resource management practices might be revitalized and reinforced where they exist or they might be introduced to areas where they are nonexistent An obstacle to this management option in Nigeria, however is the lack of adequate information upon which management actions could be based There is also insufficient information about profitability of palm forest resource exploitation for the production of goods like palm oil palm wine, and a local gin known as *ogogoro* Yet knowledge about the relationship between the profitability of production systems based on palm forest resources and intensity of exploitation is crucial to understanding how productivity and management of the resources can be improved Also the adoption of management practices by current resource users may be in jeopardy if they are unable to operate profitably But unless such practices are effective, the profitability of enterprises based on palm forest resources may turn around to fuel the devastation of the palm forest resources

The Study

In spite of the recent policy attention given to the issues of environmental stability and sustainable resource use nothing has been done in practical terms for the protection of palm forest lands Indeed government financial support for the conservation of renewable natural resources in Nigeria has not improved the renewability of mangrove and palm forest lands as compared with the forest lands in the arid vegetational belts (Olomola 1991a) Yet the palm forests account for a large proportion of palm oil production in the country

Until the mid-1950s oil palm produce was Nigeria s most important export item in value terms Today however while other crops such as cocoa and rubber remain on the list of exports palm oil has disappeared completely Between 1950 and 1960, Nigeria s exports of palm oil were about 34% of total world palm oil exports More than 80% of production then came from palm forests which were exploited by millions of small-scale subsistence farmers (Oni 1969) The country s share of world palm oil exports dropped to 25% between 1961 and 1966 3 2% during the war years (1967-69), and merely 1 1% in the immediate post-war years (1970 72) By 1975 Nigeria had become one of the palm oil importing countries and between 1975 and 1980 the annual growth rate of palm oil imports averaged 76% (Olomola 1991b) Although palm oil imports have been declining since the 1980s the growth of domestic production has been slowing Annual production increased by 7 1% in 1970-74, 4 3% in 1975-80 and 2 7% in 1981-85 that is during the second, third, and

fourth development plan periods, respectively (Olomola 1991b) This diminishing production growth is partly due to defective management of the palm forest resources

It is imperative, therefore, to examine the form, practice, and effects of traditional management of the palm forests and to evaluate its role in controlling resource exploitation and appropriation by the local communities The notion that greater involvement of local communities' knowledge and institutions could lead to more effective management is gaining ground (Klee 1980, Morauta, Pernetta, and Heaney 1982, Scudder and Conelly 1985) as pressures on forest resources have intensified not only in Nigeria but generally in the tropical and subtropical world This trend toward increased utilization of local expertise and institutional capabilities in Nigeria should be carefully investigated For instance, is there any tendency for the prevailing land tenancy to minimize resource depletion and waste generation? Under what terms are land tenancies organized in the palm forest belt? What are the mechanisms for enforcing compliance with tenancy agreements and for dealing with disputes? Has land tenancy functioned as an equitable and flexible means of regulating access to the palm forests? How has it affected sustainable resource use either through prevention of overexploitation or creation of incentives for profitable production enterprises?

This study sought to examine the traditional management practices and profitability of the production systems associated with the palm forest resources in Nigeria The specific objectives were (i) to identify the forms and terms of tenancy associated with the exploitation of palm forest resources in Nigeria, (ii) to identify the specific mechanisms for regulating access to and use of the palm forests, for enforcing compliance with tenancy agreements, and for resolving conflicts, and (iii) to examine the profitability of the traditional palm oil production enterprises and raphia winery and relate this to the extent of compliance with tenancy terms and palm forest resource management practices The study was guided by two hypotheses that the palm forest lands are managed as common property resources and that the forest land tenancy is characterized by insecurity

Review of Literature

It is common in the economic literature to examine the problem of renewable natural resource management from the property rights paradigm This approach suggests the creation of full private property rights over natural resources is a necessary condition for avoiding overexploitation Proponents of individual property rights (Gordon 1954, Demsetz 1967, Alchian and Demsetz 1973 Picardi and Siefert 1976 Johnson and Libecap 1980) treat common property and the absence of property (open access) as synonymous, and thus they argue that privatization would solve the problem of access to natural resources by granting exclusive rights to the highest bidder The management problem is presumed not to exist because the private owner would maximize the future stream of net income and so optimally allocate use rates over time by taking the right amount today and leaving the socially correct amount for the next generation Such economic interpretations have been used to justify far-reaching proposals for changing the way some common property resources are managed (Ostrom 1985, Runge 1986, Lawry 1990)

Another school of thought suggests the intervention of the state as a necessary condition for alleviating the management problems of common property resources (Hardin 1968, Bell 1972, Carruthers and Stoner 1981) This approach has been found to be ineffective because in many instances where it has been applied, the problem appears not to have been properly diagnosed Such interventions have achieved nothing but the conversion of a common property regime to open access and thus worsening the depletion of the natural resource (Cordell and McKean 1986, Messerschmidt 1986) The misconception of the nature of common property resources originates from the famous work of Hardin (1968), which he termed the 'tragedy of the commons He was metaphorically referring to the ultimate effect of the negative externality that each herder imposes on others as he adds extra animals to a pasture that has already been optimally stocked He emphasized the need for government intervention to control access and level of exploitation of the natural resource and has subsequently joined some resource economists (Hardin and Baden 1977) to advocate

the creation of private property rights as another solution to the tragedy

Nonetheless findings of empirical studies of some government land reform programs and privatization of common grazing lands (Feder 1977 1979 Jodha 1980) indicate that the proposed solutions are not likely to yield desirable results Several other writers who have contributed to the debate generated by Hardin s thesis (Ciriacy Wantrup and Bishop 1975, Dasgupta and Heal 1979 Bromley 1982 1991 McCay and Acheson 1987 Berkes et al 1989 Bromley and Cernea 1989 Gardner Ostrom and Walker 1990 Dasgupta and Maler 1991) based their criticisms on the inherent misperception of common property rights Hardin s thesis was faulted for failing to distinguish between common use situations characterized by an absence of defined property rights governing access and use typically referred to as open access, and common property defined as a distribution of property rights in resources in which a number of owners are co-equal in their rights to use the resources In other words Hardin s hypothetical pasture would fit into a regime of open access rather than common property

The misperception of the nature of common property rights is not limited to policy makers and analysts It is a source of conflict even among users of natural resources in rural communities all over the world However it is usually the desire of resource users and owners to have a suitable substitute for purely legalistic procedures that facilitates easy access and allows settlement to be achieved speedily cheaply and mutually in an informal atmosphere Three alternative approaches have been identified in the literature as suitable for resolving conflicts in such communities They are negotiation mediation and arbitration (MacDonald 1988) Negotiation could be fruitful not only when it accompanies litigation but also when undertaken separately Usually agreement is reached between the parties through discussions that are devoid of any form of compulsion As regards mediation the procedure involves the intervention of an impartial acceptable and neutral party to assist in identifying issues of mutual concern and to design solutions to such issues that are acceptable to the parties (Stulberg 1981) As with negotiation the settlement requires mutual agreement of the parties, no objectively definitive norms or principles are assumed to control the outcome In the case of arbitration the decision or settlement is made by some third parties although the basis for settlement is also mutual agreement Typically the parties agree in advance that the arbitrator s decision will be binding and final in the same way that a court decision is final Thus arbitration has more of the features of adjudication than of negotiation or mediation Agreement between the parties is limited only to a mutual desire to achieve a settlement through arbitration

The literature on land tenure and forms of tenancy in Nigeria has been concerned mainly with agricultural development and related issues (Alao 1978 Fabiyi and Adegboye 1978 Ega 1979 Famoriyo 1979 Abasiekong 1981) Some studies examine the tenure systems as it affects irrigation (Adegboye 1975) and alley farming (Francis 1987) The regulatory mechanisms relating to the exploitation of palm forests and the associated conflicts hitherto remain unresearched The attempt here is to examine the use and ownership of the palm forests within the framework of common property resource management and to identify the procedures for resolving conflicts in the local communities based on the non adjudicatory processes established in the literature

Research Methodology

The study area

The study was conducted in Ondo State one of the leading palm oil and palm wine producing states in Nigeria The state lies entirely within the tropics and covers 20 995 square kilometers The study covered Okitipupa and Ilaje/Ese-Odo local government areas (LGA) in the southern part of the state The Okitipupa LGA is among the notable palm oil producing areas in the country and is the largest in Ondo State In the 1920s Okitipupa Division alone annually exported about 5 000 tons of palm oil exports from Western Nigeria (Richards 1985) In Ondo State Ilaje/Ese-Odo is the only LGA where palm wine tapping and distillation are being carried out extensively as a business About two thirds of the LGA has numerous rivers creeks lakes, and streams where raphia palms grow luxuriantly and dominate the vegetation

Sampling and data collection

Data for this study were collected between June and August 1992, following a reconnaissance survey in the study area The study area was stratified into three zones based on the three native groups in the area—Ikale, Ilaje, Ijaw Apoi—and in view of the possible effects of cultural differences on tenancy arrangements From the Ikale zone which falls within Okitipupa LGA, four villages (Abusoro, Agbere, Igedege, and Odolawe) were selected In each of the other zones, three villages were selected (Imoluwa, Itebukunmi, and Mahintedo from the Ilaje zone and Igbekebo, Igbotu, and Sabomi from the Ijaw Apoi zone) A random sample of 20 palm wine tappers was drawn in each of the Ilaje villages and a random sample of 10 tappers was drawn in each of the Ijaw Apoi villages, thus giving a total of 90 tappers Also from each of the Ikale villages, a random sample of 20 respondents was drawn to give a total of 80 oil palm harvesters

Data collection involved key informant interviewing, administration of questionnaires, and participant observation Village chiefs, other community leaders, and representatives of land owners were chosen as key informants to gather data on the organization and structure of forest land tenancy, resource management strategies, and types of traditional authorities For more specific data on terms of tenancy, forms and resolution of conflicts security of tenure, and mode of resource exploitation, selected tappers and oil palm harvesters were interviewed Also from these respondents, quantitative data including quantity and cost of inputs, quantity and price of product rents, labor use, number of raphia palms in tapping, number of oil palm trees being harvested number of days of tapping and related variables were collected using structured questionnaires

Method of analysis

This study largely employs a qualitative analytical technique for addressing the tenurial and management issues relating to the palm forest resources in the study area The hypotheses regarding the insecurity of tenure and the common property nature of the palm forests do not require elaborate statistical testing They are verified by relating the empirical findings from the field investigations to theoretical expectations as stipulated in the literature (Famoriyo 1979, Ciriacy-Wantrup and Bishop 1975, McCay and Acheson 1987, Berkes et al 1989, Bromley 1991) Data from the field interviews were used to describe the ownership rights, tenancy arrangements, and management practices to determine the degree of tenure security and conformity with common property rules and thus to justify the possibility of relying on local collective actions for managing the palm forests

The quantitative aspect of the study focuses on profitability analysis The emphasis is on the returns to management, capital, and owned inputs among the tappers and oil palm harvesters Thus profitability is measured in terms of operating profit, which is the difference between gross revenue and total variable cost, and net income, which is the difference between operating profit and fixed cost The latter is a measure of returns to owned factors of production, mainly labor, while the former is essentially a measure of returns to capital, management, and risk

Empirical Results

Ownership rights and tenancy arrangements

Ownership rights in both the oil palm and raphia palm groves are derived from the existing customary tenure system For the oil palm groves, ownership rights are claimed by specific families or kin groups The oil palm groves have been inherited by *patrikins* (individuals who have clear patrilineal relationship to forebears who pioneered the use of the land in each village) All the patrikins are coequal owners Each member of the family can claim individual use rights but not private ownership rights For the raphia groves, ownership rights are predominantly communal All the *indi genes* (descendants of the founder) of a particular village constitute the community of co-equal owners of the raphia groves Even their heirs qualify automatically as co-owners of the groves The right of an individual under this communal tenure system covers the use of the raphia forest but not its alienation

Acquisition of use rights by tenant tappers operating in the study area is usually via rentals but

Table 1 Rents paid by Ondo State tenant tappers 1981-91 (₦/person/year)

	Ilaje Zone			Ijaw Apoi Zone		
	Imoluwa	Itebukunmi	Mahintedo	Igbekebo	Igbotu	Sabomi
1981	60	25	60	25	25	60
1982	60	25	60	25	25	60
1983	60	60	60	25	25	60
1984	120	60	60	25	25	60
1985	120	120	120	72	60	60
1986	120	120	120	72	60	60
1987	216	120	120	72	60	72
1988	216	240	120	120	60	72
1989	216	240	120	120	120	72
1990	240	240	240	240	180	120
1991	360	240	240	240	240	240
			Averages			
1981 85	84	58	72	34	32	60
1986 88	184	160	120	88	60	68
1989 91	272	240	200	200	180	144

Source Survey data 1992

involves elaborate tenancy arrangements As a rule tenant tappers should not engage in any activity other than tapping Tapping of immature raphia palms is prohibited and no tapper is allowed to fell any palm in its productive stage Tapping permission is granted on the payment of bush entry fee plus two bottles of local gin and some kolanuts Before the 1980s the entry fee was fixed at ₦1 20 but rose to ₦2 10 between 1980 and 1985 and ₦10 00 between 1986 and 1991 The payment of monthly rent has been a regular feature of the tenancy agreements in the tapping zones The rent is higher in the Ilaje zone where the demand for the local gin is greater and tapping more intensive than in the Ijaw Apoi zone (table 1)

Despite the lack of institutional constraints on the number of palms tapped there was no significant difference between the number of palms tapped daily by the indigenes and non-indigenes In the Ijaw Apoi zone the number of palms tapped daily by the non indigenes fell slightly below that of the indigenes while the reverse was the case in the Ilaje zone Indigenes tapped an average of 17 palms per day while non indigenes averaged 19 per day In the Ijaw Apoi zone 14 a day were tapped by indigenes and 13 a day by non-indigenes Also, there was only a slight difference between the proportion of tenants (non-indigenes) and indigenes claiming shortage of raphia palms Of the 7 indigenes in the sample from Ilaje zone only 2 (29%) suffered raphia shortage while 17 of the 53 non-indigenes (32%) experienced a shortage In the Ijaw Apoi zone only 1 of the 5 indigenes (20%) and 6 of the 25 non-indigenes (24%) experienced shortage of raphia palms In other words the effect of shortage of mature palms was felt fairly evenly among the tappers irrespective of their tenurial status These findings indicate that the tenancy arrangements equitably regulate access to the raphia groves

To acquire use rights in the oil palm groves a potential harvester (a stranger) had to pay an entry fee of ₦40 (1989 1991) plus two bottles of local gin and kolanuts The tenant had to pay ₦25 together with drinks and kolanuts to acquire the premises on which his camp would be constructed During the 1970s each harvester paid ₦50 per year or one tin (20 liters) of palm oil as rent This increased to ₦100 in the 1980s or two tins (40 liters) of palm oil and to ₦150 in 1990-1991 or three tins (60 liters) of palm oil Usually, the land owners preferred in-kind rent to payment in cash They often choose to sell the palm oil collected as rent in markets outside the locality and thus realize higher earnings than what could have been realized in the local market In the past this possibility of generating higher earnings from palm oil sales outside the locality largely accounted for the lack of variation in the nominal rent over periods of as much as 10 years Besides the land owners could make additional gains because they usually collected the rent at the peak period of palm oil production (between March and June) when the probability of default was slim and prices were lowest and not necessarily at the end of the year Rather than selling the palm oil in the period of collection they usually

stored it until the lean season when prices reach a peak For instance, in 1991, the average price of palm oil between March and June in the area was ₦3 75/liter compared with ₦5 94/liter in the last quarter of the year a 58% difference

As a rule, the payment of an entry fee and harvesting rent did not entitle a tenant to engage in any activity other than oil palm harvesting and processing Any harvester who was interested in farming would have had to pay additional rent, which varied from ₦100 per year in Igedege and Odolawe to ₦200 in Agbere during the 1991 production season However in Abusoro the tenants were not allowed to engage in farming under any circumstance These arrangements have varying implications for sustainable use of the palm groves and for the security of tenure in the study area

Tenure security

The security of tenure in the exploitation of the palm forest resources is crucial for the realization of the desired benefits by both the resource owners and users The necessity for tenure security is reinforced by the fact that exploitation of both the raphia and oil palm groves is largely in the hands of tenants who are strangers in the community Thus, unless the tenancy agreements guarantee the security of tenure, sustainable use of the palm forests cannot proceed unimpeded, and optimum benefits can hardly be derived For security of tenure, the tenants are expected to have a feeling of permanence in their locations with incentives for resource conservation and a continuous flow of income (Famoriyo 1979) These criteria form the basis for verifying the hypothesis that the tenancy arrangement is characterized by insecurity Our research findings indicate that this hypothesis should be rejected Access to the palm groves appeared to be secure, judging by (i) the absence of any restriction on the duration of use rights, which implies that the continuity of income flow is assured (ii) moderate access fees and uniform rent among resource users, (iii) lack of restriction on the number of raphia palms to be tapped, (iv) involvement of tenant harvesters in decisions concerning the conservation of the oil palm groves, and (v) stability of annual rents in spite of rapidly increasing product prices

The only village where tenure appears to be insecure was Abusoro where the land tenancy provided no opportunity for alternative employment even for subsistence purposes This insecurity has adversely affected the sustainability of resource use, and it is one of the causes of conflict in the management of the oil palm groves in the area

Management of palm forest resources

Both raphia and oil palm groves in the study area were managed as common property resources This was possible for several reasons The foremost is that the tenurial arrangements do not recognize individual proprietary rights Individuals had only usufructuary (and inalienable) rights This is a possibility not recognized by Hardin s model The model implicitly assumes that the interest of an individual is unconstrained by existing institutional arrangements (Hardin 1986) This assumption is untenable in the study area where the people remain tradition-bound and social sanctions are easily applied to enforce conformity with traditional practices and societal norms Moreover, enclosure of the raphia groves for private use had not been attempted by anyone, not only because of institutional constraints but also because of the prohibitive transaction costs that could be associated with the acquisition and enforcement of such private property rights Also the possibility of variations in the productivity of the palm groves both spatially and temporally means that private property rights cannot be effectively established This is because it is difficult for an individual to have access to varying portions of the groves from time to time and to bear the costs of demarcating and policing specific sites It is logical therefore, to accept the hypothesis that the palm forests are being managed as common property resources

The indivisible nature of the palm forest resource benefits and the inherent subtractability of the resources underscore the need for management that controls the behavior of resource users to prevent overexploitation In this connection, three management practices are common within the tapping communities a ban on the felling of raphia palms by the resource owners to prevent wasteful exploitation, prohibition of tapping immature palms

to enhance the renewability of the raphia groves and restriction of resource use through marking of some raphia palms by the tappers to avoid encroachment by their counterparts

In oil palm harvesting there are two important management practices One is the imposition of a closed season In the study area the harvesting season begins every year after the first week of March and ends on the 24th of December Thus a period of 10 weeks is set aside annually as the closed season One representative of the tenants and one person among the land owners often constitute a two-man team of forest guards (*olotu*) in each village to keep surveillance over the palm groves during the closed season Before the palm groves are opened again two important rituals are performed to appease the forest gods One that is jointly performed by tenant harvesters in Igedege Agbere and Odolawe involves the slaughtering of a he goat feasting and dancing and offering of prayers to a local deity *Eron* The second ritual involves the slaughtering of a goat in each of the villages to appease another deity *Ejiopa* Usually the palm forests are declared open 7 days after the *Ejiopa* rituals

The second management practice adopted by the tenant harvesters is the imposition of constraints on the number of fresh bunches that can be harvested This form of rationing is practiced in Igedege Agbere and Odolawe About 3 days into the harvesting season each harvester is allowed to harvest at most 30 ffb (fresh fruit bunches) a day After that the daily harvest is fixed at 20 ffb Tenant harvesters believe that violators of this restriction will be made to suffer by the forest gods

The actions of the tenant harvesters are consistent with the views of other scholars (Jodha 1980 Wade 1987 Dasgupta and Maler 1991) who emphasize local institutions or collective actions as suitable management structures for local common property resources and the actions tend to contradict the arguments of some critics of local collective actions (Olson 1971 Ostrom 1985) The criticisms have been based on the theory proposed by Olson (1971) stipulating that unless there is coercion or some other special device to make individuals act in their common interest rational and self interested individuals will not act to achieve their common or group interests Contrary to this proposition this study shows that the oil palm harvesters recognize the need and decide to regulate their use of the palm forests without any external influence

On the whole, the management practices have tended to be effective, judging by the extent of resource conservation the stability of the practices in the face of changing technology and economic circumstances and the high degree of compliance This is so especially in areas where the customary land tenancy guarantees suitable security of tenure It has also been possible to easily enforce compliance with the common property rules in communities where the institutional arrangements create incentives for eliminating inequities in the control of access and use of the palm forests Other factors that have facilitated easy conceptualization and understanding of the management practices as well as rule enforcement are the common traditional belief system the cohesiveness of the social structure and the homogeneity of the tenants culturally and linguistically These attributes of the traditional society, which tend to promote local collective actions are assumed away in the original model of natural resource management proposed by Hardin (1968) The model fails to recognize the self-regulating potentials of resource users, it assumes that they cannot cooperate to achieve their common interests In view of the above findings it is clear that such a model cannot have universal applicability There is also the role of economic factors in ensuring compliance with management decisions which cannot be overemphasized It is important to examine the profitability of the associated businesses because unless the tenants continue to derive economic benefits compliance with tenancy agreements and management rules cannot be sustained

Benefits of the palm forest resources

In view of the extensive market for both the local gin and palm oil the producers continue to depend on the exploitation of the palm forests as a means of livelihood But a sustainable supply of the products is desirable not only because the supply from alternative sources is grossly inadequate but also because it is becoming increasingly difficult for the resource users to find alternative employment opportunities This is the stimulus for careful management of the forest resource Indeed if proper

Table 2 Operational intensity of traditional palm oil producers, Ondo State, Nigeria, 1991

Variable	Mean	Standard deviation	C V (%)
Harvesting days in 1991 (no)	151	14 72	10
Harvesting time (hr/day)	9	0 85	9
Palm trees climbed (no /day)	26	3 82	15
Fruit bunches harvested (no /day)	30	3 13	16
Processing days in 1991 (no)	53	8 56	16

Source Survey data 1992

management had been lacking, the profitability of oil palm harvesting and raphia winery would have been adversely affected and this in turn would have stimulated outmigration of the tenant tappers and harvesters to their places of origin However, there were no reported cases of involuntary or spontaneous movement of tenants out of the palm forest resources zones either precipitated by the scarcity of alternative employment opportunities or resulting from resource management strategies That is not surprising because spontaneous outmigration by the tenants to their places of origin would be unwarranted in the absence of a better means of livelihood in such places Thus, it is in the interest of the tenants to abide by the management rules and ensure sustainable resource use

In the study area during the 1991 production season, oil palm harvesting was done for an average of 151 days, and 53 days on average were used for processing An average of 26 palm trees were climbed per day and 30 ffb were harvested per day (table 2) From a total of 4,530 ffb harvested on the

Table 4 Production costs in traditional oil palm enterprises, Ondo State Nigeria 1991

	Per enterprise (₦)	Per unit of output (₦/liter)
Operating expenses		
Hired labor	3 600 00	1 23
Climbing rope	81 50	0 03
Sharpening file	30 80	0 01
Sieve	75 70	0 03
Total	3 788 00	1 30
Fixed costs		
Cutlass	75 25	0 03
Axe	24 75	0 01
Drum	74 30	0 03
Headpan	60 25	0 02
Rent Palm forest	292 50	0 09
Processing canoe	757 00	0 26
Total	1 284 05	0 44
Total production costs	5 072 05	1 73

Source Survey data 1992

Table 3 Resource use and production pattern in traditional oil palm enterprises, Ondo State, Nigeria, 1991

Variable	Mean	Standard deviation	C V (%)
Family labor (man days)	637 50	28 64	4
Hired labor (man days)	180 85	45 80	25
Fixed capital (₦)	1 284 05	20 55	2
Working capital (₦)	3 788	216 85	6
Total ffb harvested (no)[a]	4 530	472 65	16
Output of palm oil (liters)	2 931 25	520 45	18

Source Survey data 1992

[a] ffb = fresh fruit bunches

average, it was possible to produce 2,931 liters of palm oil (table 3) The associated production cost amounted to ₦5,072 (table 4), about 75% of which represented operating expenses, while the fixed costs were about 25% This is an indication that the local palm oil production enterprise is not capital intensive Nonetheless, increases in the cost of labor (which is about 71% of total production cost) will have adverse consequences on the profitability of the enterprise In the study area, the operating profit was ₦9,952 per enterprise and ₦3 39/liter of palm oil in 1991 During the same period, net income, defined as operating profit minus fixed cost, was ₦8,668 per enterprise and ₦2 96/liter of palm oil The positive net income is an indication that oil palm production is not only profitable in the short run, but it also has prospects for being profitable in the long run This suggests that it is reasonable to strengthen the existing management practices to enhance the sustainable use of the oil palm forest

The average palm wine tapping season lasted 270 days in the Ilaje zone and 240 days in the Ijaw Apoi zone An average of 19 and 13 raphia palms, respectively, were tapped per day (table 5) The tappers were dependent on the raphia groves almost to the same degree, judging by the low coefficient of variations of palm wine, the local gin, and other variables Output of palm wine was 29 835 liters in Ilaje zone and 24,980 liters in Ijaw Apoi zone in 1991 This was processed into 2,242 and 2,027 liters of the local gin in the two zones, respectively (table 6) The associated production costs totaled ₦7,240 per enterprise and ₦3 20/liter of *ogogoro* in Ilaje zone, while in the Ijaw Apoi zone costs were ₦5,597 per enterprise and ₦2 76/liter of *ogogoro* (table 7) The cost of climbing ropes, sharpening files, and oven drum, which are used up and are frequently changed in the production

Table 5 Operational intensity of raphia tappers Ondo State Nigeria 1991

Variable	Mean	Standard deviation	C V (%)
Ilaje Zone			
Number of tapping days	270	35 53	13
Tapping hours per day	6 75	1 19	18
Raphia palms tapped per day (no)	19	3 61	19
Daily output of palm wine (liter)	10 5	0 56	8
Tapping life of a raphia palm (days)	52 5	9 48	8
Ijaw Apoi Zone			
Number of tapping days	240	26 80	11
Tapping hours per day	6 92	1 21	17
Raphia palms tapped per day (no)	13	1 73	13
Daily output of palm wine (liter)	104 08	12 15	12
Tapping life of a raphia palm (days)	43 27	10 30	24

Source Survey data 1992

Table 6 Resource use and production pattern in the raphia winery, Ondo State, Nigeria, 1991

Variable	Mean	Standard deviation	C V (%)
Ilaje Zone			
Family labor (man days)	270	55 84	21
Hired labor (man days)	208	24 60	21
Fixed capital (₦)	2 492 67	347 29	14
Working capital (₦)	4 748 08	15 94	[a]
Output of palm wine (liter)	29 835	1 127 71	4
Output of local gin (liter)	2 242	157 66	7
Ijaw Apoi Zone			
Family labor (man days)	240	88 70	37
Hired labor (man days)	156	56 44	55
Fixed capital (₦)	1 844 09	137 17	7
Working capital (₦)	3 753 53	80 25	2
Output of palm wine (liter)	24 980	890 61	4
Output of local gin (liter)	2 027	64 29	3

Source Survey Data 1992
[a] negligible

process are classified as operating expenses as distinct from the fixed costs (depreciated value) of storage drums and other fixed assets whose useful life span far exceeds the production year under review In 1991 the operating expenses constituted 66% of total production costs in Ilaje zone and 67% in Ijaw Apoi zone whereas the proportion of fixed costs was 34 and 33% in the two zones, respectively

Operating profit, as defined earlier, was ₦8,702 per enterprise and ₦3 88 per unit of output in Ilaje zone while in the Ijaw Apoi zone, it was ₦8,572 per enterprise and ₦4 23/liter of *ogogoro* Net income stood at ₦6,210 per enterprise and ₦2 77/ liter of *ogogoro* in Ilaje zone, while it was ₦6,728

Table 7 Production costs in the raphia winery, Ondo State, Nigeria, 1991

	Ilaje Zone		Ijaw Apoi Zone	
	Per enterprise (₦)	Per unit of output (₦/liter)	Per enterprise (₦)	Per unit of output (₦/liter)
		Operating expenses		
Hired labor	4 161	1 85	3 120	1 54
Climbing rope	153	0 07	163	0 08
Sharpening file	38	0 02	42	0 02
Oven drum	396	0 18	428	0 21
Total	4 748	2 12	3 753	1 85
		Fixed costs		
Cutlass	30	0 01	35	0 02
Tapping chisel	36	0 02	34	0 02
Axe	29	0 01	37	0 02
Plastic receptacles	429	0 19	222	0 11
Paddle	8	[b]	6	[b]
Funnel	18	[b]	13	0 01
Processing shed	69	0 03	68	0 03
Oven canoe	87	0 04	154	0 08
Storage drum	431	0 19	266	0 13
Distilling permit	75	0 03	75	0 04
Rent Raphia grove	280	0 12	240	0 12
Tapping canoe	480	0 21	400	0 19
Distilling pipe	520	0 23	294	0 14
Total	2 492	1 08	1 844	0 91
Total production cost	7 240	3 20	5 597	2 76

[a] Output refers to the local gin *(ogogoro)*
[b] Negligible

Table 8 Revenue and returns in the raphia winery, Ondo State, Nigeria, 1991

	Per enterprise (₦)	Per unit of output (₦/liter)
	Ilaje Zone	
Gross revenue	13 450	5 99
Operating profit	8 702	3 88
Net income	6 210	2 77
	Ijaw Apoi Zone	
Gross revenue	12 325	6 08
Operating profit	8 572	4 23
Net income	6 728	3 32

Source Survey data 1992

per enterprise and ₦3 32/liter of *ogogoro* in Ijaw Apoi zone (table 8) Although profit levels appear to be slightly higher in Ilaje than Ijaw Apoi zone, tappers in Ijaw Apoi zone are likely to be more efficient than those in Ilaje zone, judging by the observed revenue and returns per unit of output

By extending the profitability analysis to different tenurial categories—owners (indigenes) and tenants—the issue of whether the tenancy arrangements ensure equitable allocation and utilization of the raphia forest resources can be further examined In Ilaje zone, operating profit per enterprise was ₦9,755 for the owner tappers and ₦8,563 for the tenant tappers Net income per enterprise was ₦8,078 for the owners and ₦5,963 for the tenants (table 9) In the Ijaw Apoi zone, operating profit per enterprise was ₦9,612 for the owners and ₦8,364 for the tenants, while net income averaged ₦8,174 and ₦6,439 for the two categories of tappers, respectively Differences in profitability between them were not statistically significant, implying that the benefits derived from the raphia groves were distributed fairly evenly among the tappers irrespective of their tenurial status

Apart from the private benefits of the resource users (tappers and oil palm harvesters), there are others who profit by trading in palm oil and the local gin at the wholesale or retail level With regard to raphia winery, the community members as a whole also benefit through the collection of rents from the tappers The rents collected by the communities of resource owners are usually expended on community projects such as the establishment of rural markets, construction of town halls and maintenance of the waterways, which are frequently clogged by water weeds The LGA also derives benefit through the collection of a distilling permit, which is a tax levied on the production of the local gin In 1991, each of the tappers paid a tax of ₦75 to the LGA

In sum, both the palm oil enterprise and raphia winery are labor intensive and profitable The former showed higher operating profit and net income, exceeding the raphia winery by about 15% and 36%, respectively That indicated that management practices are better in the former than the latter Although the tenancy arrangements and management rules are not devoid of conflicts, they tend to encourage profitable and equitable use of the palm forests With the rising prices of palm forest products, chances are that oil palm harvesting and raphia winery will continue to be profitable for the foreseeable future

Table 9 Revenue and returns by tenurial category in the raphia winery, Ondo State Nigeria, 1991

	Ilaje Zone		Ijaw Apoi Zone	
	Per enterprise (₦)	Per unit of output (₦/liter)	Per enterprise (₦)	Per unit of output (₦/liter)
		Gross revenue		
Owner	13 980	6 01	13 105	6 21
Tenant	13 380	5 99	12 169	6 05
Difference	600	0 02	936	0 16
		Operating profit		
Owner	9 755	4 19	9 612	4 55
Tenant	8 563	3 83	8 364	4 16
Difference	1 192	0 36	1 248	0 39
		Net income		
Owner	8 078	3 47	8 174	3 87
Tenant	5 963	2 67	6 439	3 20
Difference	2 115	0 80	1 735	0 67

Source Survey data 1992

Causes and resolution of conflicts

The competence of the community of resource owners and users in the management of the resource and the resilience of the management practices are not unconnected with their capability for resolving conflicts arising from the social relations associated with the control of access to and use of the resource After all conflict resolution is essentially a question of determining use and ownership (Painter 1988) Interviews conducted in the study area revealed that conflicts have arisen over ownership of palm groves restriction of use rights and insecurity of tenure For instance there is a long history of discontent with the distribution of property rights in the raphia groves in Mahintedo where a few indigenes have been challenging the rights of the community to collect rents from tenant tappers A few self-interested indigenes lured the tappers through credit facilities and thus gained recognition as the landlord to whom rent should be paid All attempts made by the elders to stamp out this practice have proved abortive Common types of conflicts relating to use rights are (i) conflicts resulting from the violation of the rule prohibiting the felling of raphia palms by some indigenes in Sabomi in Ijaw Apoi zone (ii) the stranger versus-stranger conflicts in Ilaje and Ijaw Apoi zones over claims and counterclaims of territorial use rights in the raphia groves and (iii) conflicts among tappers over the prevention of encroachment through the marking of raphia palms that are about to mature for tapping These conflicts have led to the destruction of many palms in the study area

In Itebukunmi noncompliance with the terms of tenancy that restrict tappers to tapping only, resulted in the ejection of tappers who dabbled in fishing In Abusoro some oil palm harvesters demonstrated their objection to such a restriction (tenure insecurity) by refusing to observe the closed season aimed at achieving sustainable use of the oil palm groves Attempts to resolve these conflicts failed

It has been possible to resolve the conflicts other than those arising from tenure insecurity through negotiation mediation and arbitration However, success depends on the charisma of those involved in the implementation of the settlement, the strength of the traditional authority the commitment of the parties involved in the dispute to the terms of the consensual agreement reached, and the degree of homogeneity of the community of resource owners and disputants socially and culturally Generally the emphasis in non-adjudicatory approaches to conflict resolution in the study area is to protect the rights of the resource owners and users under the customary tenure system and to ensure sustainable use of the palm forests Such approaches were preferred to adjudication because of their speed low cost, easy access and reconciliatory tendencies

Policy Implications and Conclusions

This study has been concerned with the management of palm forest resources in Nigeria as pressures build up in several places as a consequence of increased commercialization of palm forest resources The need to address the mounting pressure is being felt by the resource owners and users, and regulatory measures have been put in place to ensure sustainable use Consequently direct intervention of the government in the control of access to and management of the palm forests seems unwarranted

The government should endeavor to strengthen existing local management systems in other parts of the country by (i) helping to define territorial boundaries especially in the raphia palm belts where they are currently nonexistent or in dispute (ii) recognizing and strengthening the traditional authority systems currently involved in palm forest resources management (iii) providing technical guidance on resource management practices (iv) creating awareness about community participation in palm forest resources management and (v) promoting the use of raphia palm seeds for reforestation programs in some riverine areas of the country that are experiencing shortage of raphia groves and where the resource users intend to intensify management The government can also help prevent over-exploitation of the palm forest resources in vulnerable areas of the country by providing social physical and institutional infrastructural facilities in rural communities to encourage investors to establish small-scale industries The availability of alternative employment opportunities in such areas

will reduce the pressure on the palm forests and thus enhance their renewability and productivity

The findings of this study have contradicted the views of some analysts that local collective actions are ineffectual in the management of common property resources due to the changing nature of village economies and social relations as well as the growing pressures on resources The prevailing tenancy arrangements in the oil palm groves tend to allocate the resource profitably and with due regard for resource conservation Under the communal management of the raphia groves, resource allocation is also profitable and equitable In situations where noncompliance with tenancy agreements and management rules has generated some conflicts, it has been possible to resolve them through negotiation, mediation, and arbitration By and large, the understanding, conceptualization and enforcement of management rules have been enhanced by the social norms and cultural values of the resource owners as well as the belief system, the cohesiveness of the social relations, and the homogeneity of the resource users culturally, economically, and linguistically

Literature Cited

Abasiekong E M 1981 Pledging oil palms A case study on obtaining rural credit in Nigeria *African Studies Review* 24(1) 73-82

Adegboye R O 1975 Irrigation and land tenure in Nigeria Paper presented at FAO/NORAD Seminar on Agricultural Sector Analysis and Planning Kabete Kenya

Alao J A 1978 Land tenure systems in Nigeria Implication for adoption of agricultural innovations *African Journal of Agricultural Sciences* 5(1) 31-39

Alchian A and H Demsetz 1973 The property rights paradigm *Journal of Economic History 13 16 27*

Bell F W 1972 Technological externalities and common property resources An empirical study of the U S northern lobster fishery *Journal of Political Economy* 80 148-58

Berkes F D Feeny B J McCay and J M Acheson 1989 The benefits of the commons *Nature* 340(6229) 91-93

Bromley D W 1982 Land and water problems An institutional perspective *American Journal of Agricultural Economics* 64 834 44

Bromley D W 1991 Testing for common versus private property Comment *Journal of Environmental Economics and Management* 21 92 96

Bromley D W and M Cernea 1989 Management of common property natural resources Overview of bank experience In *Innovation in resource management Proceedings of the Ninth Agriculture Sector Symposium* ed L R Meyers 29-45 Washington D C World Bank

Carruthers I and R Stoner 1981 *Economic aspects and policy issues in groundwater development* Staff Working Paper 496 Washington D C World Bank

Ciriacy-Wantrup, S V and R C Bishop 1975 Common property as a concept in natural resources policy *Natural Resources Journal* 15 712-26

Cordell J C , and M A McKean 1986 Sea tenure in Bahia Brazil In *Proceedings of the Conference on Common Property Resource Management* Washington D C National Academy Press

Dasgupta P , and G Heal 1979 *Economic theory and exhaustible resources* Cambridge Cambridge University Press

Dasgupta P and K Maler 1991 The environment and emerging development issues In *Proceedings of the World Bank Annual Conference on Development Economics* 101-31 Washington D C World Bank

Demsetz H 1967 Toward a theory of property rights *American Economic Review* 57 347-59

Ega L A 1979 Security of tenure in a transitory farming system The case of Zaria villages in Nigeria *Agricultural Administration* 6(4) 287 98

Fabiyi Y L and R O Adegboye 1978 The changing outlook of group farmers to land tenure in Nigeria Implications for agricultural development *African Journal of Agricultural Sciences* 5(1) 17-30

Famoriyo, S 1979 *Land tenure and agricultural development in Nigeria* Ibadan Nigeria Ibadan University Press

Feder Ernest 1977 Agribusiness and the elimination of Latin American s rural proletariat *World Development* 5 559-71

Feder, Ernest 1979 Agricultural resources in underdeveloped countries Competition between man and animal *Economic and Political Weekly* 14 (30-32) 1345-66

Francis P A 1987 Land tenure systems and agricultural innovation The case of alley farming in Southern Nigeria *Land Use Policy* 4(3) 305-19

Gardener R E Ostrom and J Walker 1990 The nature of common-property resource problems *Rationality and Society* 2 335-358

Gordon H S 1954 The economic theory of a common property resource The fishery *Journal of Political Economy* 62 124 42

Hardin Garret 1968 The tragedy of the commons *Science* 162 1243 48

Hardin G and J Baden 1977 *Managing the commons* San Francisco Freeman

Jodha N S 1980 The process of desertification and the choice of interventions *Economic and Political Weekly* 15

Jodha N S 1986 Common property resources and rural poor in dry regions of India *Economic and Political Weekly* 21 1169 81

Johnson R N and G D Libecap 1980 Agency costs and the assignment of property rights The case of southwestern Indian reservations *Southern Economic Journal* 47 332 47

Klee G A ed 1980 *World systems of traditional resource management* New York John Wiley and Sons

Lawry S W 1990 Tenure policy toward common property natural resources in Sub Saharan Africa *Natural Resources Journal* 30 402 22

MacDonnell L J 1988 Natural resources dispute resolution An overview *Natural Resources Journal* 28 7 19

McCay B J and J Acheson eds 1987 *The question of the commons Anthropological contributions to natural resource management* Tucson University of Arizona Press

Messerschmidt D A 1986 People and resources in Nepal Customary resource management systems of Upper Kali Gandaki In *Proceedings of the Conference on Common Property Resource Management* Washington D C National Academy Press

Moriuta I T Pernetta and W Heaney eds 1982 *Traditional conservation in Papua New Guinea Implications for today* Boroko Institute of Applied Social and Economic Research

Olomola A S 1991a Financial support policies for the conservation of renewable natural resources In Nigeria Paper presented at the National Workshop on Mobilising Finances for Natural Resources Conservation in Nigeria Jointly Organized by NACCRR and NISER Kongo Conference Hotel Zaria Nigeria May 7 9

Olomola A S 1991b *Financing oil palm production through contract farming* NISER Monograph Series no 6 Ibadan Nigerian Institute of Social and Economic Research

Olson M 1971 *The logic of collective action* Cambridge Massachusetts Harvard University Press

Oni S A 1969 Production response in Nigerian agriculture A case study of oil palm produce 1949 1966 *Nigerian Journal of Economic and Social Studies* 2(1) 81 91

Ostrom E 1985 *The rudiments of a revised theory of the origins survival and performance of institutions for collective action* Workshop on Political Theory and Policy Analysis Working Paper W85 32 Bloomington Indiana University

Painter A 1988 The Future of Environmental Dispute Resolution *Natural Resources Journal* 28 145 70

Picardi A and W Siefert 1976 A tragedy of the commons in the Sahel *Technology Review* 78 42 51

Richards P 1985 *Indigenous agricultural revolution Ecology and food production in West Africa* London Hutchinson & Co

Runge C F 1986 Institutions and the free rider The assurance problem in collective action *Journal of Politics* 46 154 181

Scudder T and T Conelly 1985 *Management systems for riverine fisheries* FAO Fish Technical Paper 263 Rome FAO

Stulberg S 1981 The theory and practice of mediation A reply to Professor Susskind *Vermont Law Review* 6 85 8

Wade R 1987 The management of common property resources Finding a cooperative solution *World Bank Research Observer* 2(2) 219 34

Economics of Irrigation in Crop Production in Nigeria

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SUMMARY

Nigeria's efforts at minimizing the constraint of water as an input in agricultural production in the country have been dominated by huge investments in large irrigation schemes, which have proved technical and economic failures in most cases This has led to a shift in government policy in recent years from large-scale to medium- and small-scale irrigation projects

This study was designed to estimate the economic contribution of small-scale (pump) irrigation to crop production by utilizing farm management data obtained from a sample of 100 irrigators and 110 nonirrigators in Kaduna State, Nigeria, in 1991

Production function analysis showed that the technical change introduced by small-scale pump irrigation schemes is factor-biased or non-neutral, and that technical efficiency is higher on irrigated farms than on unirrigated farms Both farm types were found to be allocatively inefficient in the use of all the production resources considered in the study In relative terms, however, irrigated farms were more allocatively efficient in the use of land

The study also showed that unirrigated farms underutilized land capital and other farm inputs for which the estimated regression coefficients were statistically significant Irrigated farms similarly underutilized land, capital, and other farm inputs and they overutilized labor and irrigation services

Budgetary analysis revealed that irrigated farms employed larger quantities of all variable inputs than unirrigated farms In addition, output per unit was much higher on irrigated farms than on unirrigated farms, and irrigated farms obtained this larger output by using larger quantities of inputs at relatively higher unit costs of production However, the per-unit profit margins remained much higher on irrigated farms

The higher levels of technical efficiency and profit margins associated with irrigated farms tend to support the current government efforts and huge investments in irrigation infrastructure as a means of increasing agricultural productivity and income in Nigeria To exploit the full potential of irrigation, farmers need a complete package of production inputs improved access to land, land consolidation through formation of producer cooperatives regular maintenance of irrigation systems to prevent frequent pump breakdown as well as training programs on the operation, maintenance, and repairs of the irrigation facilities

To attain optimality in resource allocation, unirrigated farms need to increase their employment of land, capital, and other farm inputs for which the regression coefficients were statistically significant Irrigated farms similarly need to increase their use of land, capital, and other farm inputs while reducing their employment of labor and irrigation services

Water is an important input in crop production Crops usually obtain water from natural sources such as rainfall and periodic flooding in the lowland plains of river systems However the water needs of crops are not adequately met in most ecological regions of most countries In Nigeria for example the southern forest zones have fairly sufficient water for most crops while the northern savannahs have insufficient water supply from natural sources for crop growing In such arid and semi-arid regions irrigation water is an economic input supplied at cost to farmers Even in the southern rainforest zones of Nigeria supplemental irrigation is often necessary to raise the productivity of crops Irrigation is capable of lengthening the crop season in arid semiarid and even moist subtropical lands as well as providing more year-round employment opportunities in agriculture Thus the development of irrigation infrastructure is nothing less than an agricultural revolution

Developing countries that have achieved self sufficiency in food production are ones where substantial investments in irrigation have been made as a strategy for agricultural transformation It is estimated that China and India contain more than half of the 160 million hectares of irrigated land in developing countries (World Bank 1981) In contrast irrigation is said to play a minor role in sub Saharan Africa where land under irrigation ranges from 1 to 5% in most countries as against 30% in India (Eicher and Baker 1982)

The first bold attempt at minimizing or removing the constraint of water as an input in agricultural production in Nigeria was the establishment of the river basin development authorities (RBDAs) in 1976 The RBDAs principal approach to irrigation is large capital-intensive schemes However some reviewers of large-scale irrigation projects in Africa such as De Wilde (1967) Chambers and Morris (1973) Palmer-Jones (1987) Barnett (1981) and the World Bank (1981) have described these irrigation schemes as technical and economic failures Moreover there is little involvement and commitment of farmers in these irrigation schemes They are not involved in the planning design construction operation or maintenance of the irrigation schemes Rather they are treated as farm laborers and have no control over cropping, cultivation techniques irrigation harvesting and marketing It has therefore not been easy for small, traditionally independent farmers to accept the high degree of discipline and cooperation that is required for efficient functioning of large formal irrigation schemes This has led to a call for small-scale irrigation projects where individual farmers can retain their independence and develop cooperation rather than having it imposed on them

This paper attempts to estimate the economic contribution of irrigation to crop production in Nigeria More specifically the study is designed to

- make a comparative analysis of the economic efficiencies (technical and allocative) of irrigated and unirrigated farms in Nigeria
- estimate and compare the costs and returns of the two groups of farms
- suggest ways of improving the economic contribution of irrigation to crop production in Nigeria

Recent studies on the economics of irrigation in crop production include that of Bagi (1981) in Haryana India Using a production function approach he showed that the technical change introduced by irrigation was non-neutral and that technical efficiency was higher on irrigated farms Irrigation was also found to significantly improve the relative allocative efficiency of all variable inputs

In Nigeria Oni and Ikpi (1979) studied six rice production systems traditional upland North and South improved upland North and South, improved inland swamp and irrigated The study showed that with the exception of the traditional upland North all production systems were privately profitable The improved upland North and the improved inland swamp production systems appeared slightly more profitable (privately) than irrigated rice production Socially the traditional upland systems were found unprofitable while the other three production systems were found more profitable than the irrigated system

Fatokun (1980) made a comparative study of upland swamp and irrigated rice production systems in Ogun Niger and Kwara states of Nigeria The study showed the irrigated system was the most privately profitable Besides that system, only

the swamp and irrigated rice production systems were found socially profitable

Eremie (1985) evaluated the performance of smallholder farmers in irrigated rice projects of the South Chad Irrigation Project, the Shongo Irrigation Scheme in Kwara State (both belonging to the River Basin and Rural Development Authority) and the World Bank Rice Project in Uzo Uwani, Anambra State The study showed that the World Bank project was privately profitable but socially unprofitable, and the other two were found both privately and socially unprofitable The study also showed that only the South Chad Irrigation Project was inefficient in the use of irrigation facilities In the other cases, farmers were found to be efficient in allocating their resources in rice production

Olagoke (1991) examined the efficiency of resource use in three rice production systems in Ahambra State The study showed no statistically significant differences between the net returns from irrigated rice fields and either swamp rice fields or upland rice fields Allocative efficiency tests showed that all resources were underutilized on the sampled fields during the survey year

Dittoh (1991) examined the relative economic efficiencies of different irrigation systems in Nigeria using a profit-function approach The study showed that small and large irrigated farms were economically efficient to the same degree, that informal irrigation systems were more economically efficient than formal irrigation systems, and that economic efficiency did not differ for small-scale and medium-scale irrigation technologies in the study area Factor demand functions were used to test for relative price efficiencies The analysis showed that labor was used inefficiently on large farms while fertilizers were used inefficiently on small farms It also indicated that labor and irrigation water were used more judiciously by informal irrigators than by formal irrigators Absolute price efficiency tests showed that none of the farm groups maximized profits by equating the marginal value products of all variable factors to their marginal factor costs (prices)

In conclusion, empirical literature on the economics of irrigation in Nigeria is dominated by works on large formal irrigation schemes The few studies on small-scale irrigation include those of Erhabor (1982) and Dittoh (1991), both of which compared different irrigation systems While the former compared the *shaduf* and the pump irrigation systems, the latter evaluated small-scale medium-scale, and large-scale as well as formal and informal irrigation technologies Neither of the studies compared irrigators and nonirrigators This study is designed to fill that gap

Methodology

Data

A pilot survey was carried out in January 1992 to locate small-scale irrigation projects in Nigeria Small-scale irrigation is defined as irrigation usually on small plots, in which the private farmers have the major controlling interests and that uses a level of technology that farmers can effectively operate and maintain themselves (Small-scale irrigation 1991) Emphasis is on small-scale irrigation schemes because they are bottom up in concept and execution, while large-scale schemes are top down The pump irrigation system was chosen because it was considered sufficiently divisible to be owned and operated by small-scale farmers in contrast with the situation in large capital-intensive public irrigation projects

Based on the pilot survey, Kaduna State in the northern part of the country was selected for the study Here, the State Agricultural Development Project (ADP) supplies petrol-driven irrigation pumps (a 2-inch and about 2 5 hp pump or a 3-inch and about 5-hp pump) and other facilities to farmers On the whole, there were about 500 participating farmers under the scheme located in three agricultural zones of the state Samaru, Maigana and Birnin-Gwara

For the purpose of data collection, two of these zones (Samaru and Maigana) were randomly selected for detailed study In each zone, 75 participating farmers (irrigators) and 75 nonparticipating farmers (nonirrigators) were further selected for interview Using a list of participating farmers in each zone, four local government areas were selected to yield the desired sample size and all participating farmers in the chosen local government areas were interviewed The nonparticipants were selected within the localities of participating farm-

ers to ensure homogeneity of factors except irrigation

Data collection was carried out with a structured questionnaire designed separately for irrigators and nonirrigators and related to 1991 The primary data were supplemented with secondary data obtained from officials of the state ADP

On the whole 210 completed questionnaires comprising 100 irrigated farms and 110 unirrigated farms were retrieved and used in the analysis On a zonal basis 137 questionnaires were retrieved from Samaru and 73 from Maigana The low retrieval rate in Maigana zone was as a result of the May-June 1992 civil disturbances in the state

Methods of analysis

Economic efficiency has two components technical efficiency and allocative efficiency The former refers to the ability to obtain the highest amount of output with given amounts of factor inputs The latter is the concept of efficiency in which resources are allocated in the profit-maximizing sense so that the marginal value products of resources are equal to their unit prices The absolute as well as relative allocative efficiency can be analyzed in the production function framework Technical efficiency is however sensitive to the specification of the production function

Technical efficiency

An analysis of the relative technical efficiencies of irrigated and unirrigated farms was conducted to find out whether the two groups of farms are represented by (a) neutral production function or (b) factor biased production function Neutral production functions imply that the two production functions differ significantly in one or more of the slope coefficients whether the intercept terms are the same or not To test these differences in technologies the following production function was fitted to the collected data

$$V = f(D\ H\ L\ F\ I\ K\ M\ HD\ LD\ FD\ ID\ KD\ MD)$$

where

V = value of crops and crop by-products in naira per farm

H = farm size in hectares

L = man days of labor used per annum on individual farms (including family labor and permanent and casual hired labor)

F = bags (50 kg) of chemical fertilizer used on individual farms

I = the naira value of the flow of irrigation services on individual farms (including annual depreciation charges on irrigation pumps engine tube wells and shelter as well as annual operating expenses on fuel lubrication and repairs)

K = the naira value of the flow of capital services from agricultural machinery equipment implements and tools (including depreciation charges repairs and operating expenses)

M = the naira value of other production expenses for individual farms (including costs of seeds and planting materials agricultural chemicals and miscellaneous expenses)

D = a dummy variable distinguishing farm type which takes the value of unity for irrigated farms and zero for unirrigated farms HD LD FD ID KD and MD are the slope dummies for land labor fertilizer irrigation services capital input and other farm inputs

Four functional forms (linear, semi-logarithm, double logarithm and exponential) were estimated by ordinary least squares and the lead equation was selected on the basis of the value of the coefficient of multiple determination, R^2 and the signs and the statistical significance of the estimated regression parameters If the coefficient of the intercept dummy is positive and significant this implies that the production function for irrigated farms has a larger intercept term denoting a higher level of technical efficiency and vice versa If the coefficient of the intercept dummy is zero and all the coefficients of the slope dummies are zero then the two groups of farms are represented by the same production function If the coefficients of the slope dummies are equal to zero, but the coefficient of the intercept dummy is not equal to zero then the two groups of farms are said to face neutral production functions If at least one of the slope dummies is not equal to zero, then the two groups of farms are said to face factor-biased (non-neutral) production functions (Bagi 1981)

Allocative efficiency

A rigorous comparison of the allocative efficiencies of any two groups of farms requires that they be (a) characterized by constant returns to

Table 1 Estimated exponential production function for technical efficiency test of irrigated and unirrigated farms, Kaduna State 1991

Variable	Regression coefficient	*t* ratio
Constant term (*A*)	7 653	
Dummy variable (*D*)	1 303	5 070 **
Farm size (*H*)	0 212	4 711 **
Labor input (*L*)	0 0008	2 000
Fertilizer (*F*)	0 0130	1 585
Irrigation services (*I*)	–0 0001	–0 100
Capital (*K*)	0 0005	0 083
Other farm inputs (*M*)	0 0007	3 500 *
(Farm size) *D*	0 020	0 105
(Labor) *D*	0 0009	0 900
(Fertilizer) *D*	–0 0411	–2 569 *
(Capital) *D*	0 0005	0 556
(Other farm inputs) *D*	–0 0005	–1 667
R^2	0 555	
	0 523	
F	16 866 *	
N	210	

$p < 10$ $p < 05$ $p < 01$

scale, (b) represented by the same or neutral production functions, and (c) facing the same configuration of input and output prices

To test the allocative efficiencies of the two groups of farms, the following production function was estimated for each group of farms, using the four functional forms specified earlier

$$V = f(H\ L\ F\ I\ K\ M)$$

where all variables retain their previous definitions and variable $I = 0$ for unirrigated farms

A farm is said to be price efficient or allocative efficient if it maximizes profit by equating the value of the marginal product of each variable input to its price Thus, the allocative-efficiency index for each farm type is calculated as follows

$$MVP_{ij} = P_j MPP_{ij} = r_i k_{ij}$$

$$k_{ij} = MVP_{ij} / r_{ij} = P_j MPP_{ij} / r_{ij}$$

where j represents the irrigated and unirrigated farm groups, MVP_{ij} is the marginal value product of the ith input for the jth farm type, MPP_{ij} is the marginal physical product of the ith input for the jth farm type, P_j is the output price of the jth farm type r_{ij} is the price of the ith input of the jth farm type, and k_{ij} is the allocative-efficiency parameter of the ith input of the jth farm type

However, in this study, the dependent variable, V, the gross value of crop production, is measured in naira or revenue Thus marginal value products and the marginal revenue products (partial derivatives of output or revenue in terms of the variable inputs) will be equal in this analysis Thus, P_j, the price of output, is no longer relevant and the allocative efficiency index may be calculated as

$$k_{ij} = MVP_{ij} / r_{ij} \quad (1)$$

In this study, land is measured in hectares, labor in man-days, and fertilizer in 50-kilogram bags The allocative-efficiency indices for these inputs measured in physical units are calculated using equation (1) For the remaining inputs such as capital, irrigation services, and other expenses measured in value (naira) terms rather than physical units, their allocative efficiency parameters are calculated as $k_{ij} = MVP_{ij} / r_{ij}$

The allocative efficiency index is a measure of efficiency in resource use The input is overutilized if $k < 1$ and underutilized if $k > 1$ Absolute allocative efficiency requires that $k_{ij} = 1$ for all inputs The two groups of farms would have achieved equal allocative efficiency if $k_{i1} = k_{i2}$ for every input

Empirical Analysis and Results

Technical efficiency tests

The exponential production function was chosen as the lead equation based on the value of the coefficient of multiple determination, R^2, as well as the signs and statistical significance of the estimated regression parameters (table 1) About 56% of the total variation in farm output is explained by the variables indicated in the model The coefficients of farm size, labor, other farm inputs, and the intercept dummy are all positive and statistically significant, while those of irrigation services, fertilizer, and capital are insignificant In terms of the slope dummies, those of fertilizer and farm inputs are negative but significant, while those of farm size, labor, fertilizer, and capital are insignificant

The positive and highly significant coefficient of the intercept dummy in the lead equation implies that the production function for irrigated farms has a larger intercept term, denoting higher level of technical efficiency for irrigated farms Moreover, the statistical significance of the slope dummies for both fertilizer and other farm inputs implies that the

two groups of farms are represented by factor-biased or non-neutral production functions

Allocative efficiency tests

On the basis of the value of the coefficient of multiple determination R^2 the signs and statistical significance of the estimated regression parameters the double logarithmic function was chosen in each case as the lead equation for the different farm groups and the pooled sample (table 2)

For irrigated farms the explanatory variables jointly accounted for about 80% of the total variation in farm output In addition the coefficients of farm size labor irrigation, capital and other farm inputs are positive and statistically significant, while the coefficient of fertilizer is negative and insignificant

For unirrigated farms, about 83% of the total variation in farm output is explained by the combined effect of the explanatory variables Only the coefficients of farm size, capital, and other farm inputs are statistically significant

With regard to the pooled sample the explanatory variables jointly accounted for about 57% of the total variation in farm output The coefficients of farm size labor, irrigation and other farm inputs are positive and significant at 1% while those of fertilizer and capital are insignificant

Using the double logarithmic production function which is the lead equation for the two farm types and the pooled sample the allocative-efficiency indices for land labor and fertilizer are derived (Bagi 1981 Onyenwaku and Awuja 1991) as $k_{ij} = a_{ij}(V_i / X_{ij}) / r_{ij}$ while those of irrigation services capital and other farm inputs are calculated as $k_{ij} = a_{ij}(V_i / X_{ij})$ where a_{ij} is the output elasticity or regression coefficient of the ith input V_i is the geometric mean of output, and $\bar{X}_{ij}$ is the geometric mean of the ith input Other variables are as defined earlier

The allocative efficiency parameters shown in table 3 indicate that both irrigated and unirrigated farms underutilize land capital, and other farm inputs However irrigated farms underutilize land relatively more than unirrigated farms while unirrigated farms underutilize capital and other farm inputs relatively more than irrigated farms Moreover irrigated farms make intensive use of both labor and irrigation services Therefore irrigated farms deviate relatively less in the absolute allocative efficiency criteria than unirrigated farms in the use of capital and other farm inputs and deviate more in the use of land

Table 2 Estimated double logarithmic production functions for allocative efficiency test of irrigated and unirrigated farms and the pooled sample, Kaduna State, 1991

	Regression coefficients		
Variable	Irrigated farms	Unirrigated farms	Pooled sample
Constant term (Ln*A*)	7 622	5 962	4 995
Farm size (Ln*H*)	0 956	0 729	0 377
	(7 134)	(4 314)	(2 618)
Labor input (Ln*L*)	0 148	0 075	0 409
	(1 805)	(586)	(3 858)
Fertilizer (Ln*F*)	–0 043	0 042	–0 021
	(–0 422)	(677)	(–0 724)
Irrigation (Ln*I*)	0 064	–	0 073
	(2 370)		(7 300)
Capital (Ln*K*)	0 069	0 121	0 075
	(1 816)	(2 161)	(1 364)
Other inputs (Ln*M*)	0 141	0 206	0 227
	(2 712)	(3 433)	(3 547)
R^2	0 799	0 826	0 570
	0 783	0 816	0 555
F	48 400	84 383	37 107
N	100	110	210

Notes Figures in parentheses are t ratios
$p < 10$ $p < 05$ $p < 01$

Tests for constant returns to scale

The estimated scale elasticities (returns to scale) are 1 335 for irrigated farms 1 173 for unirrigated farms and 1 140 for the pooled sample Statistical tests show the deviations of the scale elasticities from unity to be nonsignificant in all the samples (table 3) These results imply that the irrigated farms, unirrigated farms and the pooled sample are characterized by constant returns to scale

Production costs and returns

The production costs and returns of the two groups of farms are presented in tables 4 and 5 The results show that the gross revenue for irrigated farms is ₦18 680 per farmer or ₦7 983/ha compared with ₦13 244 per farmer or ₦3,853/ha for unirrigated farms Similarly the average cost of production is ₦9,609 per farmer or ₦4,132/ha for irrigated farms and ₦7 592 per farmer or ₦2 209/ha for unirrigated farms The resultant net returns

are ₦9,071 per farmer or ₦3 851/ha for irrigated farms and ₦5 652 per farmer or ₦1,644/ha for unirrigated farms These results imply that irrigated farms produce higher quantities of output at relatively higher unit costs of production than unirrigated farms However, per-unit net returns are much higher on irrigated farms Consequently, irrigation increases the profit margin In addition, the per-hectare values of all production inputs are generally higher for irrigated farms This result implies that irrigation increases the use of all inputs

Conclusions and Policy Recommendations

The higher levels of technical efficiency and profit margins associated with irrigated farms relative to unirrigated farms tend to support the current government efforts and huge investments in irrigation infrastructure as a means of increasing agricultural productivity and income in Nigeria The increased profits on irrigated farms have the potential of enabling irrigators to purchase larger quantities of inputs which could improve both technical and allocative efficiencies leading to further increases in output

To exploit the full potential of irrigation, farmers need a complete package of production inputs This would involve integrating irrigation technology with reliable and economical supply of other inputs such as improved seeds fertilizers agricultural chemicals, and labor It also requires economically accessible markets for inputs and outputs as well as favorable producer input and output prices However, such conditions were virtually absent in the study area Most farmers (irrigators and nonirrigators) complained about the scarcity and high costs of such inputs, as well as lack of production credit and the small size of plots Farmers need credit not only to adopt and implement irrigation technology but also to expand the scale of farm operations and to hire labor needed for increased agricultural production This, therefore, calls for increased provision of soft loans to farmers as well as intensification and improvement of the country s rural banking schemes There is also a need for policies designed to improve the farmer's access to land and to promote land consolidation through the formation of farmers producer cooperatives

Table 3 Production elasticities, marginal value products, factor prices, and allocative efficiency parameters for irrigated and unirrigated farms Kaduna State, 1991

Item	Irrigated farms n = 100	Unirrigated farms n = 110	Pooled sample n = 210
	Production elasticities		
Land	0 956	0 729	0 377
Labor	0 148	0 075	0 409
Fertilizer	–0 043	0 042	–0 021
Irrigation	0 064		0 073
Capital	0 069	0 121	0 075
Other inputs	0 141	0 206	0 227
Return to scale	1 335	1 173	1 14
Deviation of returns	0 335	0 173	0 14
to scale from unity	(0 312)	(0 409)	(0 621)
	Sample means		
Land (ha)	2 34	3 437	2 925
	(0 99)	(2 134)	(1 756)
Labor (Man days)	220 25	281 611	238 994
	(105 301)	(233 487)	(165 092)
Fertilizer (bags)	13 480	12 063	12 697
	(7 184)	(9 129)	(8 303)
Irrigation (₦)	2 146 562		981 194
	(988 480)		(1 262 235)
Capital (₦)	118 486	108 366	114 005
	(121 812)	(106 683)	(135 400)
Other inputs (₦)	560 830	374 916	453 291
	(543 541)	(330 586)	(443 621)
Output (₦)	18 679 91	13 243 853	15 450 017
	(11 869 110)	(12 149 331)	(12 253 745)
	Marginal value products		
Land (₦/ha)	7 631 621	2 809 069	1 991 336
Labor (₦/man day)	12 552	*	26 440
Fertilizer (₦/bag)		*	
Irrigation (₦/N)	0 557		1 149
Capital (₦/N)	10 878	14 789	
Other inputs (₦/N)	4 696	7 277	7 737
	Factor prices		
Land (₦/hectare)	600	300	450
Labor (₦/man day)	20 42	18 65	19 54
Fertilizer (₦/bag)	65 34	68 44	66 89
	Allocative efficiency indices		
Land	12 72	9 36	4 43
Labor	0 61		1 35
Fertilizer			
Irrigation	0 56		1 15
Capital	10 88	14 79	*
Other inputs	4 70	7 28	7 74

Source Regression results

Note Figures in parentheses are standard errors

*Estimate/index was not derived because estimated regression coefficient was not statistically significant

Table 4 Costs and returns of irrigated farms, Kaduna State, Nigeria 1991

Item	Unit price (₦)	Units per farmer	Value per farmer (₦)	Units per hectare	Value per hectare (₦)
		Revenue			
Gross			18 679 91		7 982 87
		Production costs			
Capital operating expenses					
Seed			259 21		110 77
Fertilizer (50 kg bag)	65 34	13 48	880 78	5 76	376 36
Agrochemicals			70 63		30 18
Tractor hire			186 37		79 65
Irrigation costs			1 676 40		716 41
Other			44 62		19 07
Total			3 118 01		1 332 41
Labor input (man days)					
Hired labor	20 42	63 33	1 293 20	27 06	552 57
Family labor	20 42	156 92	3 204 31	68 34	1 395 50
Total		220 25	4 497 51	95 40	1 948 07
Total variable costs			7 615 52		3 280 48
Fixed cost					
Depreciation					
Irrigation system			470 62		201 12
Other tools and equipment			118 49		50 64
Land rent	600	2 34	1 404 00	1	600 00
Total			1 993 11		851 76
Total costs			9 608 63		4 132 24
		Return			
Net			9 071 28		3 850 62

Source Field study Kaduna State 1991

Table 5 Costs and returns of unirrigated farms Kaduna State, Nigeria, 1991

Item	Unit price (₦)	Units per farmer	Value per farmer (₦)	Units per hectare	Value per hectare (₦)
		Revenue			
Gross			13 243 85		3 853 32
		Production costs			
Capital operating expenses					
Seeds			302 35		87 97
Fertilizer (50 kg bag)	68 44	12 063	825 59	3 51	240 22
Agrochemicals			8 82		2 57
Tractor hire			38 09		11 08
Other			25 66		7 47
Total			1 200 50		349 24
Labor input (man days)					
Hired labor	18 65	46 70	870 96	13 59	253 45
Family labor	18 65	234 91	4 381 07	68 35	1 274 73
Total		281 61	5 252 03	81 94	1 528 18
Total variable cost			6 452 54		1 877 42
Fixed cost					
Depreciation			108 37		31 53
Land rent	300	3 437	1 031 10	1	300 00
Total			1 139 47		331 53
Total costs			7 592 01		2 208 95
		Return			
Net			5 651 84		1 644 37

The reliability and efficiency of irrigation water delivery systems should also be improved through efficient pumping mechanisms, the delivery of production inputs at the right time and in the right amounts and proper maintenance of the irrigation system to minimize idle time arising from pump breakdown This also calls for training farmer participants in the construction, installation, operation, and maintenance of the irrigation facilities

The study showed that the technical change introduced by pump irrigation schemes in Nigeria is factor-biased and labor augmenting It is thus encouraging to note that irrigation increases the labor-absorption capacity of the agricultural sector This knowledge is crucial for a labor surplus economy like Nigeria where the industrial sector s rate of employment generation is slow

Unirrigated farms were found to underutilize all production resources such as land, capital, and other farm inputs considered in this study This implies that allocative efficiency cannot be attained through the substitution of one resource for another Rather, the needed re-organization is that of scale, involving increased employment of all resources by nonirrigators However, irrigators were found to underutilize land, capital, and other farm inputs and overutilize irrigation services and labor Therefore, there is scope for irrigators to further increase the use of land, capital, and other farm inputs while reducing the use of labor and irrigation services in order to attain allocative efficiency

In conclusion, this study has shown that unlike most formal large-scale irrigation projects, which have proved both economic and technical failures in Nigeria the small-scale (pump) irrigation system has an important role to play in agricultural development in terms of the vast opportunities for improving farm incomes and living standards as well as for contributing toward national self-sufficiency in food production For the success of such small-scale irrigation schemes, it is essential that farmers be involved in their planning design, construction, operation, and maintenance Farmers should also exercise control over their irrigated lands In addition, the types of irrigation technology used should be appropriate and comprehensible to the small farmers who must be able to maintain and repair them

Literature Cited

Bagi F S 1981 Economics of irrigation in crop production in Haryana *Indian Journal of Agricultural Economics* 81(6) 15-26

Barnett T 1981 Evaluating the Gezira Scheme Black box or Pandora s box In *Rural development in tropical Africa* ed J Roberts and G William New York Saint Martins Press

Barrow C 1987 *Water resources management and agricultural development in the tropics* London Longmans

Chambers R and Morris J eds 1973 *Nuea An irrigated rice settlement in Kenya* Munich Institut fur Wirtschaftsforchung

De Wilde J 1967 The Office Du Niger An experience with irrigated agriculture In *Experience with agricultural development in tropical Africa* vol 2 Baltimore Johns Hopkins University Press

Dittoh S 1991 Efficiency of agricultural production in small and medium-scale irrigation in Nigeria In *Issues in African rural development 1991* ed C R Doss and C Olson 152-74 Arlington Virginia Winrock International

Eicher C K and D C Baker 1982 *Research on agricultural development in sub Saharan Africa A critical survey* International Development Papers no 1 Department of Agricultural Economics East Lansing Michigan State University

Eremie S N 1985 Economics of small holder irrigated rice production with special implications for the river basin development authorities in Nigeria Ph D thesis, University of Ibadan Nigeria

Erhabor P O 1982 Efficiency of resource use under small scale irrigation technology in Nigeria A case study of sheduf and pump in Ringin Local Government Area Kano State Ph D thesis Purdue University

Fatokun O Y 1980 A comparative study of upland swamp and irrigated rice production in Ogun Niger and Kwara states of Nigeria M Sc thesis University of Ibadan Nigeria

Olagoke M A 1991 Efficiency of resource use in rice production systems in Ahambra State Nigeria In *Issues in African rural development* ed C R Doss and C Olson 319-42 Arlington Virginia Winrock International

Oni S A and A E Ikpi 1979 *Rice production and marketing in Nigeria An economic appraisal* Monrovia West African Rice Development Association

Onyenwaku C E and C O Awuja 1991 Allocative efficiency in pig production in Imo State Nigeria *Modeling Simulation and Control* (France) 28(2) 51 63

Palmer Jones R 1987 Irrigation and politics of agri cultural development in Nigeria In *State oil and agriculture in Nigeria* Institute of African Studies Berkeley University of California

Small scale irrigation Opportunities for success 1991 *Spore* (Technical Centre for Agricultural and Rural Development Netherlands) no 36 1 4

World Bank 1981 *Accelerated development in sub Saharan Africa An agenda for action* Washington D C

Cost Recovery, Equity, and Inefficiency in Irrigation Schemes in Sudan

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SUMMARY

Irrigated agriculture is the backbone of Sudan's economy The success or failure of irrigated agriculture in Sudan has been primarily attributed to the production relations policy Production relations was governed by the Joint Account System (JAS) until 1980/81 when because of serious flaws in the JAS, an alternative policy known as the Individual Account System (IAS) was adopted

A landmark of the IAS was a water charge instrument, which had been advocated by the World Bank, among others, motivated by economic and financial objectives including cost recovery, equity, efficiency, and fiscal improvement In Sudan, the capital and recurrent costs of irrigation water are greater than the costs of any other input Hence, a system of charging beneficiaries is considered of importance in the formulation and operation of irrigation schemes

In this study, we approached the land and water charge policy from a purely financial view point to examine cost recovery, efficiency, and equity Secondary financial data were collected from the records of the Gezira Scheme, the Rahad Scheme, and the Ministry of Irrigation covering 1981/82 to 1990/91 The quantitative data was supplemented by qualitative data obtained through interviews with key managers in these organizations It was found that irrigation schemes are far from achieving full cost recovery The average levels of cost recovery for Gezira and Rahad are 52% and 60%, respectively It was also found that cost allocations between crops are distorted, and accordingly some crops are unfairly taxed Moreover, managerial inefficiency in setting water rates, controlling costs, budgeting, and collecting water charges was found to have far-reaching implications for cost recovery and equity

Based on these findings some policy interventions are proposed First, the level of cost recovery should be based on actual expenditure and not accrued charges This is because evidence has shown that actual expenditure has always largely exceeded accrued charges Second, the major factors that lead to better recovery performance are government control of a crop and crop profitability However, high cost recovery performance due to crop control should not be encouraged because it will ultimately affect agricultural development adversely Improvement of crop profitability seems to be a better strategy to enhance cost recovery performance Third, the official view that all unrecovered costs are tenants debts is not justified In fact three of the four factors leading to unrecovered costs are symptoms of managerial inefficiency in the agricultural schemes and the Ministry of Irrigation rather than of the unwillingness or inability of farmers to pay

Sudan's economy has been deteriorating since the late 1970s as a consequence of droughts in 1983/84 1984/85 and 1989/90, the civil war since 1983 and above all mismanagement of the economy Exports have fallen noticeably, imports have risen and foreign exchange is meager External debt reached US$13 billion Inflation was above 100% in 1992 with serious problems of shortages in energy Real GDP had negative growth in fiscal years 1988 and 1990 and very small growth in other years With a population increase of about 3% per annum the country's per capita output has fallen

If there is any hope for Sudan in the foreseeable future it is going to be in the reorganization and development of its agricultural potential The Central Bank of Sudan (1984) reported that 92% of Sudan's export earnings originate in the agricultural sector (cotton groundnut gum arabic, sesame and livestock) The sector also provides almost 80% of the required food and about 90% of the raw materials required by local industry (World Bank 1984) Moreover it provides the livelihood for about 80% of the population

Sudan's agriculture comprises three distinct subsectors traditional rainfed mechanized rainfed and irrigated About two thirds of the population depend on rainfed agriculture for their living Farming in the rainfed subsector occupies 22 million feddans of which about 10 million are under mechanized farming and 12 million are farmed traditionally Hence this subsector is vital to Sudan's food security

The irrigated subsector consists of six major schemes developed and owned by the government in which 4 5 million feddans are farmed It is dominated by the Gezira Scheme which was the first large-scale gravity irrigation project in Sudan

Managerially each scheme is run as a parastatal corporation The government appoints the managing boards and provides financial resources Managing boards acquire and provide inputs to farmers in kind in addition to some cash advances The Ministry of Irrigation (MOI) provides and manages irrigation water up to minor canals and the farmers provide labor This tripartite arrangement usually referred to as production relations has not been without problems, which often invite policy makers to intervene Under the current production relations, the agricultural corporations are supposed to recoup all of their production costs plus a charge for the use of land and irrigation water The land portion of the charge is meant to finance the administrative budgets of corporations, whereas the water portion is meant to recover the costs of the MOI

As part of the government's endeavors to rehabilitate its irrigated agriculture, the World Bank agreed to fund the Agricultural Rehabilitation Programme (ARP), which effectively started in late 1979 The World Bank agreed to rehabilitate (1) the physical capacities of the agricultural corporations (2) the management systems of the agricultural corporations, and (3) the irrigation facilities on conditions that the government of Sudan would review its policy and practice of irrigated agriculture as follows

1 In the short run, the World Bank required a review of production relations
2 In the long run, the World Bank required a review of the concept of agricultural parastatals owned and managed by the government

Consequently, in 1981 the government reviewed and changed production relations from the Joint Account System (JAS) to the Individual Account System (IAS), effective from season 1981/82 This change of policy was viewed as giving farmers more incentives to increase production and accordingly create stability in the subsector

In practice production relations are nothing but the accounting system that governs the allocation of costs and distribution of profits among farmer tenants, managing boards, and the government Prior to 1981/82, the agricultural corporations managed their production relations with farmer tenants using the JAS The main feature of that system is that costs and revenues are jointly accounted for The system was abandoned because of cross-subsidization among tenants The landmark of the IAS, which replaced the JAS, was the creation of the land and water charge policy as an alternative way to finance the administrative budgets of the managing boards and the MOI The IAS treats tenants separately as regards costs and revenues (Ahmed 1991)

The Literature

Economic theorists have extensively analyzed ways of setting prices in order to allocate resources efficiently For instance, it is often argued that a free-market system of price setting will produce an efficient allocation of resources and allow free individual decision making However, in some other instances, society may be willing to set prices that allow for some inefficiency in order to attain other goals such as equity in the distribution of resources

Economic theory on pricing has drawn from three schools of thought Public utility regulation, public finance, and welfare economics, which emphasizes marginal cost pricing (Mushkin 1972) In each of these areas of knowledge, pricing is used to achieve a particular set of functions The role of the economist is to propose pricing schemes that best fit these functions For irrigation water management, the evaluation of any pricing scheme rests on the consideration of four functions allocative efficiency, cost recovery, equity, and administrative concern (Elobied 1986, Sharief 1992)

The functions of a water-charging system cited above are embedded in three broad objectives—economic, financial and social (Carruthers and Clark 1981) The financial objective of a water charge system is achieved through a cost-recovery function Irrigation cost recovery has been defined by Svendsen (1992) as The process of directly or indirectly capturing and directing to public agencies some portion of revenue resulting from government actions to provide irrigation services, regardless of whether or not these funds are used to pay for any construction or operation and maintenance costs

It is a topical issue because cost recovery (and loan repayment where foreign borrowing is involved) is a well-established principle of public finance and public investment and because irrigation cost recovery usually falls short of the expectations of planners and international lenders A number of factors have led to increased attention to cost recovery from beneficiaries

1 National debt burdens are becoming oppressive for many countries and governments are looking for ways to contain indebtedness and repay loans
2 The huge increases in recurrent costs of irrigation due to expanding area
3 The perception that poor operational performance of many irrigation schemes is related to inadequate recurrent cost financing
4 The perception that investment decisions have been distorted by private and political incentives because of the large subsidies and economic rents involved in irrigation development

Mobilizing resources through a system of water charges is not an end in itself but a means of achieving specific ends Small (1990) summarizes these ends as follows

1 Improvement of irrigation performance through more efficient operations and maintenance of irrigation facilities—by improving funding and accountability and encouraging greater cooperation and involvement of water users—and more efficient use of water by farmers
2 Promotion of government objectives such as encouraging better investment decisions easing government fiscal burden, and achieving more equitable distribution of income

Cost recovery involves some basic issues including the classification of cost recoveries costs to recover, the bases of irrigation fees, type of collection bodies and modes of collection Cost recovery has been classified as direct or indirect and automatic or discretionary Direct recoveries are those borne by beneficiaries in the command area such as the collection from water fees Indirect recoveries represent all increases in government revenues due to an irrigation project, but that are not paid by beneficiaries in the command area Automatic cost recoveries are those attributable to the existing tax instruments, whereas the discretionary are those attributable to instruments that are purposely introduced to increase the level of recovery (Roumasset 1987) In this study, it is only the direct and automatic irrigation water fees that we emphasize

Countries differ in their policies on what types of costs to include for the purpose of recovery In the Sudan, according to Dingle (1992) cost recovery is achieved via a composite rate for both water and land The costs to recover include, through a water charge, capital cost of the irrigation system, consisting of depreciation, replacement cost reserve, and interest on long-term debt, operations

and maintenance cost of the MOI overhead costs (a portion of MOI headquarters overhead charged to each scheme according to volume of water consumed) and through a land charge the administrative budget of the agricultural corporation (It was decided that the agricultural corporations were entitled to an income by virtue of owning or administering the land)

Musgrave (1959) outlined the benefits approach and the ability-to pay approach as the fundamental means for defining equity The benefits approach looks at the relationship of the beneficiary to the public agency where the beneficiary is expected to pay in full the costs of the services received Under this approach full cost recovery is regarded as equitable since beneficiaries pay the costs The ability-to-pay approach addresses income distribution where the liability of the beneficiary is limited to his ability to pay i e those who are more able, pay more The level of cost recovery here is determined by the desire of decision makers, whether administrators or politicians to subsidize agriculture

However any charging system must be sensitive to issues such as variations in production from one season to another, inequitable water distribution in the system (head and tail) and the inefficiency of irrigation authorities in providing water on time and in the right amount (Svendsen 1986) It is this last view of equity that we incorporate in this study

Research Problem, Objectives, and Hypotheses

In Sudan the capital and recurrent costs of irrigation water are higher than any other agricultural input costs Hence a system of charging beneficiaries should be considered of importance in the formulation and operation of irrigation schemes (Elobied 1986)

As early as 1918/19 water charges were introduced in the Northern province of Sudan The charge covered running expenses and was set at £S4 per feddan of wheat crop with an index to other crops according to number of waterings In 1952 the rates were modified to cover, in addition replacement depreciation and other extraordinary expenditures (Ministry of Irrigation 1978)

At the agricultural corporations (parastatals) the system was first introduced at Suki in 1971 and then at Rahad in 1976 The rate in both schemes was a land and water charge based on a flat rate per holding (Ministry of Irrigation 1978) The land and water charge system was introduced in all other schemes (including Gezira) in 1981/82 in response to the World Bank policy recommendations There had been various earlier proposals advocating a water charge instrument (World Bank Gezira Study Mission 1966, Gezira Working Party 1964 Hashim Committee 1973 Imam Committee 1975 etc) The implemented system is based on cropped area, with rates varying with the crop s estimated water use

World Bank policy recommendations have been motivated by a number of economic and financial objectives including cost recovery equity, operating efficiency, and fiscal improvement In this study, we approach the land and water charge policy from a purely financial view point to answer the following questions

1 To what extent have the agricultural corporations and the Ministry of Irrigation (MOI) recovered their costs?
2 How are the land and water charges set and to what extent are they fair and equitable for farmers and among different crops ?
3 What is the extent of the operating inefficiencies of the agricultural corporations and the MOI, and to what extent have the inefficiencies been considered in setting land and water charges?
4 Have the land and water charges been set at a level high enough to enable the system to raise enough funds to meet the budgets of MOI and the agricultural corporations?

As outlined above, the major objectives of the study are

1 To assess the extent of cost recovery from land and water charges in Gezira and Rahad schemes from 1981/82 to 1990/91
2 To assess the extent to which the land and water charge system has been equitable and fair in the Gezira and Rahad schemes
3 To assess and quantify the relative inefficiencies of Gezira Rahad, and the MOI, to investigate the reasons for inefficiencies, and to see to what extent land and water charges have been adjusted for such inefficiencies, if any

4 To investigate and assess the accounting techniques and institutional setting used in fixing land and water charges
5 To provide an overall evaluation of the policy for land and water charges after 10 years of implementation

In order to be able to investigate the research questions raised above, we have developed specific research hypotheses that relate to the body of knowledge we have about irrigated agriculture

1 Irrigation costs of the MOI and the agricultural corporations are not fully recovered because of the variations in farm income
2 The determination of land and water charges is based on capital, operating, and maintenance costs
3 There is a degree of inefficiency on part of the MOI and the agricultural corporations, which accounts for some costs passed on to farmers
4 The agricultural corporations have not remitted any funds to the MOI or the central treasury because of their budget deficits

Research Methodology

The research was carried in the Gezira and Rahad schemes, Sudan's two largest irrigation schemes Gezira and Rahad together have about 75% of the cultivated area of the irrigated subsector In Gezira the cultivated area of 2 1 million feddans is farmed by 102,000 tenants The cultivated area in Rahad is 300,000 feddans, which is farmed by 15,000 tenants The Gezira headquarters is about 189 kilometers south of Khartoum and the Rahad headquarters is 290 kilometers south The area is arid with seasonal rainfall (July-September) of not more than 20 inches The Ministry of Irrigation has its headquarters and most of its field operations in this area, too

The irrigation schemes have similar cropping patterns rotating cotton, wheat, groundnuts, and dura However, the extent of intensification, tenancy size, and number of rotations differ Gezira has a four-course rotation system having a tenancy size between 15 and 20 feddans, and an intensification level of 66% In contrast Rahad has a two-course rotation system, a tenancy size of 22 feddans, and a 100% level of intensification

To test the research hypotheses, we developed a questionnaire to collect quantitative data from a sample of the agricultural corporations (Gezira and Rahad) and the MOI The questionnaire was in the form of tables ready for enumerators to fill when data were retrieved A separate table was designed for each research variable Data compiled in these tables were mostly financial and covered 1981/82 to 1990/91, the first decade of the implementation of the land and water charge system in Gezira

We also collected qualitative data by interviewing a sample of executives, managers, and farmers in the agricultural corporations (Gezira and Rahad) and the MOI

Analysis of Empirical Data

Cost structure

The costs of an irrigation scheme can be divided into administrative and production costs The administrative costs do not directly relate to agricultural operations and include

- Salaries, wages, allowances, pensions, and overtime of the administrative staff
- Service expenses such as fuel, oil, office supplies, interest, car operating expenses, and maintenance related to administration
- Capital expenditures cars, buildings, and equipment related to administrative functions

Management annually prepares a budget of administrative costs to be financed by collections from farmers through the land and water charge levied on all crops The Ministry of Finance may finance the deficit if the collections fall short of actual administrative expenditure Over the past few years, the capital expenditures incurred under the administrative budget have in the main been financed by the Gezira Rehabilitation Project via a long-term loan from the World Bank

Production costs are those that directly relate to agricultural operations and are either a direct charge to an individual tenancy account or are allocated on a predetermined basis Production costs are automatically recovered as management deducts them from the proceeds of the crops under its control

Gezira Scheme

Level of cost recovery

Table 1 shows the calculation of cost recovery in the Gezira Scheme for the study period Costs to recover are composed of actual administrative expenditure of the Gezira Scheme and actual expenditure of the MOI in Gezira (actual costs of water management in the scheme) Actual collections represent what is actually levied via the land and water charge system on all crops in Gezira Then actual collections are related to the costs to recover and percentages to estimate the level of recovery are calculated It can be seen that during the study period the level of cost recovery in Gezira ranged from a minimum of 40% in agricultural season 1984/85 to a maximum of 66% in 1990/91 The average level of cost recovery for the study period was 52%

Analysis of unrecovered costs

The unrecovered cost of Gezira was analyzed utilizing a financial variance analysis methodology Djikerman (1988) of the World Bank in Sudan, offered four reasons why some costs are not recovered

1 The agricultural corporations and the Ministry of Irrigation have always overrun their budgets
2 The planned production area is reduced later in the agricultural season due to irrigation problems and other reasons
3 Tenants do not pay their dues of land and water charges in full for various reasons
4 Land and water rates are recalculated each season based on percentage increases over actually approved budgets of the previous year and not on that season s budgeted costs

For this study, each of the above reasons were developed into a formula and then quantified as a financial variance With the data collected from the accounts and archives of the Gezira Scheme the following variances were calculated cost overrun variance, budget rate variance, area cutout variance, and tenants debts variance

Cost overrun variance Historical data have shown that the agricultural corporations and the MOI have always exceeded their approved budgets As long as actual expenditure exceeds the budgets a variance termed cost overrun variance occurs The land and water charge system could not recover overrun costs because these costs have not initially been incorporated into the rate-setting formula The combined cost overrun variance for Gezira and the MOI in Gezira can be quantified as follows

$$\begin{bmatrix} \text{Gezira actual admin} \\ \text{expenditure} \\ + \\ \text{MOI actual expenditure} \\ \text{for Gezira} \end{bmatrix} \quad \begin{bmatrix} \text{Gezira admin} \\ \text{budget} \\ + \\ \text{MOI budget for} \\ \text{Gezira} \end{bmatrix}$$

Applying this formula to our secondary data produces the cost overrun variance for Gezira and the MOI separately for the study period Then these variances are aggregated into a combined cost overrun variance Table 2 shows that on average Gezira has overrun its budget by 22% while the MOI has overrun its budget for Gezira by 26% The combined cost overrun variance for the study period is 24%

Table 1 Gezira Cost recovery

	Costs to recover (£S 000)				
Season	Gezira actual expenditure	MOI actual expenses in Gezira	Total	Actual collections (£S 000)	Cost recovery (%)
1981/82	10 425	16 052	26 477	17 078	65
1982/83	16 162	19 998	36 159	16 745	46
1983/84	32 215	26 671	58 886	27 172	46
1984/85	37 991	28 685	66 676	26 466	40
1985/86	40 963	30 880	71 844	44 955	63
1986/87	66 476	42 602	109 078	54 240	50
1987/88	76 764	76 472	153 237	66 547	43
1988/89	121 083	107 703	228 786	96 760	42
1989/90	107 261	184 865	292 126	134 560	46
1990/91	136 846	242 996	379 842	252 719	66
Total	646 186	776 924	1 423 110	737 242	52

Table 2 Gezira Administrative account budget compared with actual expenditures (£S 000)

	Gezira administrative account budget vs actual expenditure			MOI budget and actual expenditure in Gezira			Combined
Season	Budget	Actual	Cost overrun variance (SGB)	Budget	Actual expenditures	Cost overrun variance (MOI)	cost overrun variance
1981/82	9 767	10 425	(658)	14 774	16 052	(1 278)	(1 935)
1982/83	14 453	16 162	(1 709)	17 519	19 998	(2 479)	(4 188)
1983/84	18 120	32 215	(14 095)	30 771	26 671	4 100	(9 996)
1984/85	38 008	37 991	17	22 174	28 685	(6 510)	(6 494)
1985/86	48 635	40 963	7 672	27 386	30 880	(3 494)	4 178
1986/87	46 886	66 476	(19 591)	37 795	42 602	(4 807)	(24 397)
1987/88	53 806	76 764	(22 958)	47 376	76 472	(29 097)	(52 055)
1988/89	71 911	121 083	(49 173)	53 045	107 703	(54 658)	(103 831)
1989/90	103 556	107 261	(3 705)	124 755	184 865	(60 110)	(63 815)
1990/91	122 850	136 846	(13 996)	243 050	242 996	54	(13 942)
Total	527 991	646 186	(118 195)	618 645	776 924	(158 278)	276 474

Budget rate variance Land and water rates are theoretically set on the basis of approved budgets, but, in fact each year rates are set based on percentage increases over historically approved budgets When the budgets for any year are approved, they have always been more than the raised actual budgets To this extent, another variance called budget rate variance occurs It results from a budgeting error that affects the process of setting the rate This variance can be quantified as follows

$$\left[\begin{array}{c}\text{Actually approved Gezira admin budget}\\+\\\text{Actually approved MOI budget for Gezira}\end{array}\right] - \left[\begin{array}{c}\text{Historically approved MOI and Gezira budgets raised by percentage factors}\end{array}\right]$$

One difficulty in calculating this variance was that the percentage increases that the land and water charge committee used during the study period could not be obtained Consequently we worked backwards, multiplying the land and water rates by the budgeted areas for each crop Then we summed these amounts to arrive at the raised historical budgets Table 3 shows that the aggregate budget rate variance for the study period is 17% of total Gezira and MOI budgets

Area cutout variance Another contributor to recovery shortfalls is the fact that planned areas are put out of production later in the season due to shortages of irrigation water Because the approved budgeted costs are to be recovered through the charges on all the planned production areas a variance arises, termed area cutout variance This variance can be quantified as follows

$$\left[\begin{array}{c}\text{Charge rate}\\\text{x}\\\text{Planned production area}\end{array}\right] - \left[\begin{array}{c}\text{Charge rate}\\\text{x}\\\text{Actual production areas}\end{array}\right]$$

Budgeted land and water charge is the multiplication of planned production areas and charge rates, whereas accrued land and water charge is the multiplication of actual production areas and charge rates Table 4 shows the aggregate area cut-

Table 3 Budget rate variance (£S 000)

Season	SGB budget	MOI budget	Total	Rate based budget	Budget rate variance
1981/82	9 767	14 774	24 541	26 060	1 518
1982/83	14 453	17 519	31 972	23 974	(7 998)
1983/84	18 120	30 771	48 891	38 317	(10 574)
1984/85	38 008	22 174	60 182	41 071	(19 111)
1985/86	48 635	27 386	76 022	58 826	(17 196)
1986/87	46 886	37 795	84 680	69 141	(15 539)
1987/88	53 806	47 376	101 182	86 374	(14 808)
1988/89	71 911	53 045	124 956	119 943	(5 013)
1989/90	103 556	124 755	228 311	173 161	(55 150)
1990/91	122 850	243 050	365 900	314 762	(51 139)
Total	527 991	618 645	1 146 637	951 627	(195 010)

Table 4 Gezira Area cutout variance and tenants' debts variance (£S 000)

Season	Area cutout variance	Tenants debts variance
1981/82	(1 830)	(7 152)
1982/83	(2 331)	(4 898)
1983/84	(1 702)	(9 943)
1984/85	(883)	(13 722)
1985/86	423	(14 293)
1986/87	(630)	(14 271)
1987/88	(1 134)	(18 692)
1988/89	(5 725)	(17 457)
1989/90	(1 651)	(36 951)
1990/91	9 999	(72 042)
Total	(5 463)	(209 422)

out variance which amounts to 5 7% of budgeted land and water charges

It is worth mentioning that all the crops except sorghum have shown unfavorable area cutout variances Production areas initially planned for other crops are later reduced and re-allocated to sorghum as it requires less irrigation Consequently the area cutout variance due to other crops is partly offset by extra levies on sorghum growers

Tenants debts variance The agricultural corporations accrue as their primary income land and water charges on all crops To the extent that all or part of the accrued land and water charges are not collected the agricultural corporations record receivables on their books of accounts which represent tenants debts As a matter of fact uncollected land and water charges are only one source of tenants debts Costs of inputs services and cash advances could also end up as debts if revenues do not cover production costs In this study we are only concerned with tenants debts attributable to land and water charges (LWC) To quantify this variance the following formula was used

Accrued LWC – Actually recovered LWC

The data we collected gives land and water charges tenants debts variance by crop (whereas in table 4 it is shown as aggregate) All crops have unfavorable variances although the variance due to sorghum predominates

	Variance (£S 000)	*% of total*
Cotton	32 436	15 8
Wheat	31 106	14 8
Groundnut	12 908	6 0
Sorghum	121 324	57 8
Vegetables	11 648	5 6
Total	209 422	100

The land and water charges tenants debts variance is alarming It accounts for 31% of unrecovered costs (table 5) Moreover the variance due to sorghum accounts for 57 8% of the total variance Interviewees in Gezira management attribute this to the following

1 Sorghum is a tenants crop that is out of the control of management Hence the policy is that tenants have to pay land and water charges for sorghum in cash However, debts accumulate because tenants are either unwilling to pay or seldom have excess cash to pay
2 The practice in Gezira is that management debits land and water charges due from sorghum to individual cotton accounts when farmers fail to pay cash But most of the tenants who grow sorghum either do not grow cotton or have incurred losses on their cotton accounts
3 Sorghum is not a cash crop but the staple food for farmers As a result payment of land and

Table 5 Gezira Summary of variances 1981/82-90/91 (£S 000)

Season	Cost overrun variance	Budget rate variance	Area cutout variance	Tenants debts variance	Total
1981/82	(1 935)	1 518	(1 830)	(7 152)	(9 399)
1982/83	(4 188)	(7 998)	(2 331)	(4 898)	(19 414)
1983/84	(9 996)	(10 574)	(1 702)	(9 943)	(32 215)
1984/85	(6 494)	(19 111)	(883)	(13 722)	(40 210)
1985/86	4 178	(17 196)	423	(14 293)	(26 888)
1986/87	(24 397)	(15 539)	(630)	(14 271)	(54 837)
1987/88	(52 055)	(14 808)	(1 134)	(18 692)	(86 690)
1988/89	(103 831)	(5 013)	(5 725)	(17 457)	(132 026)
1989/90	(63 815)	(55 150)	(1 651)	(36 951)	(157 566)
1990/91	(13 942)	(51 139)	9 999	(72 042)	(127 123)
Total	(276 474)	(195 010)	(5 463)	(209 422)	(686 368)
Aggregate variance relative to total unrecovered costs (%)	40	28	0 8	31	100

Table 6 Rahad Cost recovery

Season	Cost to recover (£S 000)	Actual recoveries (£S 000)	Level of recovery (%)	Unrecovered costs (Total variance £S 000)
1981/82	15 601	3 248	21	12 353
1982/83	16 722	3 129	19	13 593
1983/84	17 604	5 355	30	12 250
1984/85	22 380	7 244	32	15 136
1985/86	24 544	15 000	61	9 544
1986/87	28 657	19 082	67	9 575
1987/88	30 506	22 871	75	7 635
1988/89	33 952	25 315	75	8 636
1989/90	38 629	26 420	68	12 208
1990/91	45 481	36 929	81	8 552
Total	274 074	164 592	60	109 482

water charges in cash has always been difficult

4 The favorable sorghum area cutout variance is another reason for the alarming sorghum tenants' debts variance Cutout areas reallocated to sorghum mostly end up as contributors to tenants debts

Summary of variances

Table 5 summarizes the variances, which together add up to total unrecovered costs due from land and water charges It can be seen that unrecovered land and water charges are dominated by the cost overrun variance amounting to 40% Tenants debts variance accounts for 31%, followed by the budget rate variance amounting to 28% However, the area cutout variance is negligible These percentages pinpoint certain policy issues and management processes to target for review For instance the cost overrun variance enables us to question the proper functioning of the budgeting process The budget rate variance questions the rate setting process, whereas the tenants' debts variance points to the inefficiency of the collection system

Rahad Scheme

Level of cost recovery

The level of cost recovery in the Rahad Scheme is calculated as the percentage of actual recovery to the cost-to-recover Actual recovery is the collection from tenants in the form of land and water charges as recorded in the books of accounts Cost-to-recover is the summation of actual administrative expenditure by Rahad and actual water management expenditure by the MOI in Rahad

Table 6 shows that the level of cost recovery was as low as 19% in financial year 1982/83, but as high as 81% in 1990/91 Clearly the recovery level was too low in the first 4 years after the introduction of the land and water charge policy However from 1985/86 onwards the level of cost recovery noticeably increased from a minimum of 61%

Table 7 Rahad Summary of variances 1981/82-90/91 (£S 000)

Season	Tenants debts variance	Budget rate variance	Area cutout variance	Cost overrun variance	Total
1981/82	(3 515)	(7 211)	(725)	(901)	(12 353)
1982/83	(3 583)	(8 907)	(732)	(372)	(13 593)
1983/84	(6 088)	(5 811)	541	(892)	(12 250)
1984/85	(4 675)	(6 207)	(1 155)	(3 098)	(15 136)
1985/86	(451)	(6 525)	(1 974)	(594)	(9 544)
1986/87	(355)	(5 954)	(299)	(2 267)	(8 875)
1987/88	(207)	(4 679)	(2 279)	(470)	(7 635)
1988/89	(3 243)	(1 182)	(2 490)	(1 721)	(8 636)
1989/90	(7 923)	2 773	(3 004)	(4 054)	(12 208)
1990/91	(11 324)	17 801	(12 108)	(2 922)	(8 552)
Total	(41 365)	(25 903)	(24 225)	(17 290)	(108 783)
Aggregate variance relative to total unrecovered costs (%)	38	24	23	15	100

to a maximum of 81% The average cost recovery for the study period is 60%

Analysis of unrecovered cost

Unrecovered cost amounts to £S109 million in nominal terms (table 6) This sum alternatively called the total variance can be analyzed according to the main reasons underlying unrecovery Cost overrun area cutout tenants not paying and the setting of rates lower than they should have been are such reasons Applying the formulas introduced in the Gezira analysis the total variance has been broken down into four components as shown in table 7 The total variance is dominated by the tenants debts variance amounting to 38% The budget rate variance and the area cutout variance are 24% and 23% respectively Of least importance is the cost overrun variance 15%

Tenants debts variance Tenants debts due to unrecovered land and water charges, over the study period amount to £S41 4 million, which is equal to 20% of what the scheme has accrued over the same period (table 8) However looking at the annual variance in relation to accrued costs reveals no consistency The ratio of tenants debts to accrued charges was as low as 1% in one season, but as high as 53% in another A number of reasons have been explored to explain why this ratio is so different from one year to another

1 Costs accrued but not paid in a previous season could be recovered in any of the following seasons
2 Land and water charges on tenants own crops (groundnuts sorghum and vegetables) are debited to individual cotton accounts if they are not paid in cash immediately For that reason such charges could be recovered only in good cotton seasons
3 Debt collection is more vigorous in some seasons depending on the Ministry of Finance, which initiates collection only when it encounters serious budget deficits

Table 8 Rahad Tenants' debts variance

	Land and water charges (£S 000)			
Season	Accrued	Recovered	Variance	%
1981/82	6 763	3 248	(3 515)	52
1982/83	6 711	3 129	(3 583)	53
1983/84	11 443	5 355	(6 088)	53
1984/85	11 918	7 243	(4 675)	39
1985/86	15 451	15 000	(451)	3
1986/87	19 438	19 082	(355)	2
1987/88	23 078	22 871	(207)	1
1988/89	28 558	25 315	(3 243)	11
1989/90	34 344	26 420	(7 923)	23
1990/91	48 252	36 929	(11 324)	24
Total	205 957	164 592	(41 365)	20

Budget rate variance The budget rate variance evaluates the process whereby land and water rates are set The national land and water committee has never set the exact rates that will enable cost recovery From 1981/82 to 1988/89, rates were set lower than they should have been by as much as 54% in one season (table 9) However these gaps have continuously narrowed to reach only 4% in 1988/89 The steady decline reflects the learning process associated with the budgeting experience In the last two seasons of the study period, rates were set higher than they should have been by 8% and 42% respectively Although the favorable budget rate variances in the last two seasons positively affect the total variance and thus cost recovery their effect is negative on equity, a constraint of cost recovery

Table 9 Rahad Budget rate variance

Season	Rahad budget (£S 000)	MOI budget for Rahad (£S 000)	Total (£S 000)	Rate based budget (£S 000)	Budget rate variance (£S 000)	Variance as % of budget
1981/82	9 500	5 200	14 700	7 488	(7 211)	49
1982/83	10 850	5 500	16 350	7 443	(8 907)	54
1983/84	11 212	5 500	16 712	10 902	(5 811)	35
1984/85	12 501	6 780	19 281	13 074	(6 207)	32
1985/86	15 750	8 200	23 950	17 425	(6 525)	27
1986/87	17 441	8 950	26 391	20 437	(5 954)	23
1987/88	20 916	9 120	30 036	25 357	(4 679)	16
1988/89	22 730	9 500	32 230	31 048	(1 182)	4
1989/90	24 125	10 450	34 575	37 348	2 773	8
1990/91	25 619	16 940	42 559	60 360	17 801	42
Total	170 643	86 142	256 785	230 882	(25 903)	

Table 10 Rahad Aggregate area cutout variance (£S 000)

Season	Cotton	Wheat	Groundnuts	Sorghum	Total
1981/82	(186)		(508)	(32)	(725)
1982/83	(538)		(83)	(111)	(732)
1983/84	1 045		(314)	(190)	541
1984/85	(880)		(11)	(264)	(1 155)
1985/86	(1 230)		(238)	(506)	(1 974)
1986/87	(801)		(449)	951	(299)
1987/88	(2 010)		(63)	(207)	(2 279)
1988/89	(2 184)		(388)	82	(2 490)
1989/90	(1 882)	(148)	(106)	(868)	(3 004)
1990/91	(5 704)	(3 803)	(440)	(2 161)	(12 108)
Total	(14 370)	(3 951)	(2 599)	(3 306)	(24 226)
	58%	16%	10%	16%	100%

Area cutout variance The area cutout variance evaluates the effects on cost recovery from the combined inefficiency in agricultural management (scheme administration) and water management (MOI) Area is cut out of production because of shortages of inputs and irrigation water It is evident in table 10 that the area cutout variance is dominated by cotton area cutout variance, which accounts for 58% of the total As the cotton occupies, on average, 50% of the total production area, it can be concluded that cotton is responsible for more than its justifiable share of unrecovered costs by 8% of the total area cutout variance Interviewees said that of all crops cotton is the most demanding for inputs and water so it suffers more cutouts than other crops

Cost overrun variance The cost overrun variance explores the inefficiency of the budgeting process and evaluates how such inefficiency affects the recovery of land and water cost Budgeting inefficiency exists at the stage of budget preparation, the follow-up stage, or both For the study period, the combined cost overrun variance for both Rahad and the MOI in Rahad, £S17 3 million, is 16% of total unrecovered cost for the same period (table 11) Rahad contributes 68% of this variance, whereas, the MOI in Rahad contributes 32% This is justifiable because the actual total expenditure (cost-to-recover) for the study period is 67% for Rahad and 33% for the MOI in Rahad

Looking at the cost overrun variances independently, the Rahad variance amounts to 6 9% of its actual administrative expenditure The MOI in Rahad variance equals to 6 4% of its expenditure These low ratios might suggest budgeting efficiency rather than inefficiency However this is not the case These ratios are aggregates that conceal serious budget overruns that in some years reach 30%

Policy Analysis and Implications

Empirical and conceptual studies have approached the water charge problem through an analytical framework emphasizing cost recovery, equity and fairness, administrative inefficiency and

Table 11 Rahad Budget compared with actual expenditure and the cost overrun variance (£S 000)

	Rahad			MOI in Rahad			Combined
Season	Budget	Actual	Cost overrun variance	Budget	Actual	Cost overrun variance	cost overrun variance
1981/82	9 500	9 900	(400)	5 200	5 700	(500)	(901)
1982/83	10 850	11 211	(361)	5 500	5 511	(11)	(372)
1983/84	11 212	12 191	(979)	5 500	5 414	86	(892)
1984/85	12 501	14 314	(1 814)	6 780	8 065	(1 285)	(3 098)
1985/86	15 750	16 421	(671)	8 200	8 123	77	(594)
1986/87	17 441	19 530	(2 089)	8 950	9 127	(177)	(2 267)
1987/88	20 916	21 802	(886)	9 120	8 703	417	(470)
1988/89	22 730	23 953	(1 223)	9 500	9 998	(498)	(1 721)
1989/90	24 125	25 125	(1 006)	10 450	13 503	(3 053)	(4 054)
1990/91	25 619	27 930	(2 311)	16 940	17 551	(610)	(2 922)
Total	170 643	182 378	(11 735)	86 142	91 696	(5 555)	(17 290)
Variance relative to budget (%)			6 9			6 4	6 7

practicality This part of the paper analyzes the results in light of previous empirical and conceptual work to assess existing policies

Cost identification and control

Costs incurred by the agricultural corporations and the Ministry of Irrigation (MOI) are not well identified or controlled Irrigation costs have been classified into four headings Chapter I Chapter II Chapter III and Development This classification may not be appropriate for decision making purposes such as pricing water Reclassifying costs according to behavior (direct/indirect fixed/variable) and according to type (product/period input/labor/overhead) could be more appropriate and useful Second the agricultural corporations and the MOI have continuously overrun their budgets by an average of more than 30% This indicates that budgets are carelessly set financial control is not exercised or both It is unfair that unproductive irrelevant, and extravagant costs are passed on to the users of irrigation services An improvement through the installation of proper cost and management accounting systems would improve recovery performance through the enhancement of pricing on one hand and financial discipline on the other

Cost recovery

The World Bank and Sudan Government have stated, as their cost recovery objective an optimum recovery level (less than full) for 1988/89 but full cost recovery afterwards Table 12 compares three previous studies and this one There are significant methodological differences among these studies First, the degree of coverage varies from 1 to 10 years, which affects the comparability of results Second the studies have varied with respect to the denominator figures used in calculating recovery levels While the present study and Abushora (1989) used actual expenditure the other studies used accrued charges However, all of the studies used actual collections of land and water charges as their numerator

The findings of the present study, supported by all previous studies, show that the agricultural corporations are far from achieving full cost recovery The studies that used actual expenditure as their denominators reported lower levels of cost recovery (20% 52% and 60%) than those that used accrued charges (79% 81% and 91%) The calculation of the level of cost recovery should be based on actual expenditure and not accrued charges Evidence has shown that actual expenditure has always largely exceeded accrued charges because

1 The agricultural corporations have always overrun their budgeted expenditure
2 Land and water rates have always been set lower than should have been because of the erroneous practice of basing rates on previous plans plus an arbitrary percentage increase
3 The agricultural corporations take out of production some planned area in midseason due to irrigation difficulties

It should be noted that our study and Abushora (1989) obtained largely different results of cost recovery levels in Gezira even though both of them used actual expenditure as their denominators The former arrived at a level of 52% whereas the latter obtained a result of 20% We attribute this variation to the degree of coverage, being 3 years for Abushora but 10 years for this study Taking an average from our data for the same period studied by Abushora we have obtained a result of 45% indicating that these 3 years exhibit much lower recovery levels than the overall average

Cost recovery performance calculated on a crop basis varies from one crop to another Crop recovery performance is calculated as the ratio of actual

Table 12 Average cost recovery in Gezira and Rahad schemes

Study	Scheme	Degree of coverage (no of years)	Period	Average cost recovery
Abushora (1989)	Gezira	3	1985/86 87/88	20%
Land and Water Charge Study (Water Committee 1988)	Gezira Rahad and Halfa	3	1985/86 87/88	97% Gezira 91% Rahad
AUAC (1990)	Gezira	1	1989/90	81%
This study	Gezira and Rahad	10	1981/82 90/91	52% Gezira 60% Rahad

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collections attributable to a crop to land and water charges accrued on that crop Table 13 reports the results of three studies, which all agree that, vegetables and cotton have the highest recovery performance Vegetables have the highest returns (AUAC 1990, Water Committee 1988) so farmers who grow them are better able to pay In contrast cotton is fully controlled by the government, which collects the proceeds and then deducts land and water charges before any payments are made Sorghum, groundnuts, and wheat have lower recovery performance because they have lower returns and are not controlled by the government If a crop is not controlled by the government, farmers market it themselves, collect the proceeds and often escape paying the land and water charges It can be concluded that crop recovery performance is mainly determined by the extent of crop control by the government and crop profitability (returns), which enhances farmers ability to pay

However, despite its effectiveness in achieving high recovery performance, crop control should be carefully and critically viewed On the one hand, it is at odds with the free-market principle It is a paradox that the present government claims to have instituted agricultural policies conforming with the market economy On the other hand crop control means producer prices, which have always dismotivated farmers In Gezira there is an abundance of evidence that farmers have abandoned or decreased cultivation because of government control Therefore the high cost recovery performance of cotton should not be misleading It should not be understood as a positive indicator that would enhance agricultural development The improvement of crop profitability seems to be the best strategy to enhance cost recovery performance and simultaneously to improve agricultural development

The land and water charge study (Water Committee 1988) arrived at the conclusion that

> Cropping pattern and tenancy size affect the recovery rate In Rahad for example cotton occupies a large portion of the scheme about 50% of the total area In Gezira and New Halfa the area grown by cotton represents 31% and 33% of the whole area respectively Therefore it could be argued that the area grown by cotton would reflect the recovery rate

The higher recovery level in Rahad compared with Gezira can not be simply attributed to crop

Table 13 Cost recovery by crop (%)

	Land and water charge study (3 yr avg)		This study (10 yr avg)	AUAC study (1 yr)
Crop	Gezira	Rahad	Gezira	Gezira
Cotton	91	92	90	96
Wheat	77		87	94
Groundnuts	47	87	76	70
Sorghum	47	87	52	55
Vegetables	100		93	91
Avg	79	91	80	81

In Rahad due to accounting problems we could not calculate recovery by crop because the actual collections could not be segregated

pattern and tenancy size It is true that crop pattern and tenancy size vary from Rahad to Gezira, but it is difficult to establish a correlation or causation Instead, recovery levels are higher in Rahad because the recovery level of cotton is normally higher in all schemes—cotton is controlled by the government, which makes cost recovery easy to exercise Also, farmers in Rahad were accustomed to paying land and water charges because the system was introduced when the scheme began In contrast the land and water charge was recently introduced in Gezira where farmers had previously had a different practice

This study, unlike previous work, did not stop with the calculation of recovery levels, but went further into the financial analysis of unrecovered costs Unrecovered costs are not all the result of tenants' failure to pay, as officially understood In fact other reasons such as the overrun of budgets, low budgeted land and water rates, and the elimination of some areas midseason contribute most to unrecovered costs Nonetheless, the books of accounts (official understanding) consider all unrecovered costs as tenants' debts

Tenants' debts, according to the books of accounts, have increased enormously during the last two decades to the extent that agricultural development in the irrigation subsector is adversely affected Debts have accumulated over the years and only small portions are being repaid Heavily indebted farmers may not receive profits, even in a good season, because of the repayments of previous debts As a result, such farmers are not motivated to produce, and often abandon farming altogether A farmer may neglect a crop because it is heavily indebted, shifting his efforts to an unindebted one, a practice that is adversely affecting scheme level and overall agricultural strategies The illegal selling of

inputs a popular practice in irrigation schemes has been observed to be more common among indebted farmers The strong farmers union of Gezira went on strike twice during the 1980s demanding debts forgiveness

As a consequence the government has continuously intervened enforcing policies that range from stringent debts collection directives to debts forgiveness In fact when the government decided in 1980 to change production relations from the JAS to the IAS one of the reasons was debts What is the reality of these debts then?

This analysis challenges the official practice—on which policy has always been based—which considers all unrecovered land and water charges as tenants debts In fact three of the four reasons leading to unrecovered costs reflect the managerial inefficiency of the agricultural corporations For that reason unrecovered costs due to budget overruns low budgeted rates and area cutouts should not be passed on to farmers Reclassifying unrecovered costs according to managerial inefficiency on one hand and failure of tenants to pay on the other reveals that tenants should have been responsible for only 30% and 38% of unrecovered land and water charges in Gezira and Rahad respectively Over the years real debts in Gezira and Rahad seem to be very low compared with their official levels as table 14 demonstrates

The exceptionally high ratios of real debts to book debts in Gezira in 1981/82 (76%) and 1990/91 (52%) need to be explained The first year for the land and water charge system was 1981/82 and resentment of new ideas was natural In 1990/91 the government shifted agricultural resources from cotton to wheat in an attempt to close a serious food gap Because wheat has a lower recovery level, tenants debts increased The high figures in Rahad in 1989/90 and 1990/91 (53% and 44%, respectively) reflect the introduction of wheat in Rahad at the expense of cotton beginning in 1989/90

We therefore recommend a policy option that would call for the analysis of unrecovered land and water charges according to the underlying reasons so as to assign responsibility fairly We propose that only unrecovered land and water charges due to tenants failure to pay (the difference between accrued land and water charges and actual collections) should be considered as tenants debts Those due to managerial inefficiency should be blamed on management so as to encourage financial discipline

Equity and fairness

The pricing of land and water services has mainly been based on the number of watering per season that a crop requires as determined by specialists of the Agricultural Research Corporation However empirical evidence has proved that some crops have not received what the specialists recommended due to various irrigation management problems The head-tail phenomenon of large scale gravity irrigation (Fakki Elobied and Elbdawi 1985) canal maintenance difficulties and farmers misbehavior (stealing water flowing to a neighbor at night) are examples of such problems As a consequence it has been found that in both Gezira and Rahad, only vegetables and sorghum have received the required number of irrigations or more Vege

Table 14 Real debts compared with official (book) debts due to land and water charges (LWC)

	Gezira			Rahad		
Season	Book debts due to LWC (£S 000)	Real debts (£S 000)	%	Book debts due to LWC (£S 000)	Real debts (£S 000)	%
1981/82	9 399	7 152	76	12 353	3 515	28
1982/83	19 414	4 898	25	13 593	3 583	26
1983/84	31 714	9 943	31	12 250	6 088	50
1984/85	40 210	13 722	34	15 136	4 675	31
1985/86	31 488	14 293	45	9 544	451	5
1986/87	55 838	14 271	26	9 575	355	4
1987/88	86 689	18 692	22	7 635	207	3
1988/89	132 027	17 457	13	8 636	3 243	37
1989/90	157 567	36 951	23	12 208	7 923	65
1990/91	137 123	72 042	52	8 552	11 324	–
Total	701 469	209 421	30	109 482	41 364	38

tables and sorghum enjoy the utmost commitment of farmers because vegetables provide the highest returns and sorghum is the staple food Even if all crops receive the right number of irrigations, the measure still suffers a major drawback Deliveries are not of a standard nature as neither the volume nor the duration of a delivery are measured

The pricing system also assumes that crops receive equal amounts of administrative services, so land charges are uniform Empirical evidence has proved that administrative services have varied across crops due to the government preference for cotton (a strategic cash crop) and wheat (a strategic import-substitution foodcrop) As an example, cotton has received 50% of the administrative services in Gezira and 63% in Rahad

The national land and water charge committee has been using MOI actual expenditure in 1980/81 (£S14 million for Gezira and £S3 million for Rahad) as a base to calculate the water charges for the successive seasons after making a hypothetical annual increase This methodology is not scientific and may either understate or overstate rates Actual expenditure has progressively increased to reach £S243 million and £S17 6 million in 1990/91 for Gezira and Rahad, respectively

These findings have far reaching implications for the water charge system and ultimately agricultural development Cost allocation between crops is distorted and accordingly some crops are unfairly taxed This will reduce their profitability, which may ultimately lead farmers to abandon farming these crops altogether Unfairness could also creep in adversely affecting the relationship between users and suppliers of irrigation water Distortions could lead to over- or undertaxation of farmers While the former may force farmers out of the job the latter may threaten the sustainability of irrigation services at least in the long run Therefore, for policy consideration, the water charge system should consider the inefficiency of suppliers along with the variations among crops in receiving services Such policy is in line with the recommendations of many water management specialists including Chaudry (1985), Small (1990), and Svendsen (1986)

Conclusions

This research has mainly looked at the problem of cost recovery in the major irrigation schemes in Sudan, Gezira and Rahad, and found that the agricultural corporations and the Ministry of Irrigation (MOI) do not properly identify and classify costs Hence the institution of proper cost and management accounting systems is needed to improve water pricing and financial discipline Also, the agricultural corporations were found to be far from achieving full cost recovery The average levels of cost recovery for Gezira and Rahad were 52% and 60%, respectively The divergence of this result from those of previous studies stems mainly from the methodology of calculating the level of cost recovery Therefore as a policy intervention we propose that the level of cost recovery should be based on actual expenditure and not accrued charges This is because evidence has shown that actual expenditure has always largely exceeded accrued charges

Cost recovery performance on a crop basis was very high for cotton and vegetables, but low for groundnuts, wheat, and sorghum Crop control by the government and crop profitability are the factors that lead to better recovery performance However, high cost recovery performance due to government control of the crop should not be encouraged In the long run, such policy may adversely affect agricultural development The improvement of crop profitability seems to be the best strategy to enhance cost recovery performance and accordingly agricultural development

These findings challenge the official view, which considers all unrecovered costs as tenants debts In fact three of the four reasons leading to unrecovered costs are symptoms of managerial inefficiency of the agricultural corporations and the MOI rather than the unwillingness or inability of farmers to pay We therefore argue that unrecovered costs due to budget overruns, low budgeted rates, and area cutouts should not be passed on to farmers Policy makers, in their efforts to improve cost recovery through the water charge system, should emphasize the managerial inefficiency of the agricultural corporations and the MOI, which are responsible for most of the unrecovered costs

Literature Cited

Abushora Y A 1989 *Cost recovery in Gezira Scheme* Medani Sudan Hydraulic Research Station Ministry of Irrigation

Ahmed F E 1991 The effects of changes in production relations on tenants debts The case of Sudan Gezira Scheme *Public Enterprise Journal* 11(4) 268 78

AUAC (Advisory Unit for Agricultural Corporations) 1990 *Cost recovery in Gezira* Khartoum

Carruthers I and C Clark 1981 *The economics of irrigation* Liverpool University Press

Central Bank of Sudan 1984 *Annual report* Khartoum

Djikerman A 1988 *Land and water charges—issues for discussion* Khartoum World Bank

Dingle M A A 1992 Cost recovery issues related to irrigation services—policy options In *Workshop on irrigation water charges* Was Medani Sudan International Irrigation Management Institute

Elobied H A 1986 Economics of charging for irrigation water in the Gezira Scheme Sudan Ph D diss Colorado State University Fort Collins

Fakki H A H A Elobied and A Elbdawi 1985 The effects of farm location on cotton yields and farm incomes in the Gezira Scheme In *Water distribution in Sudanese irrigated agriculture Productivity and equity* ed Osman A Fadl and Charles R Bailey Wad Medani Sudan University of Gezira

Ministry of Agriculture 1978 *Annual report* Khartoum

Musgrave R A 1959 *The theory of public finance* New York McGraw Hill

Mushkin S J 1972 *Public price for public product* Washington D C Urban Institute

Roumasset J 1987 *The public economics of irrigation management and cost recovery* Agriculture and Rural Development Department Washington D C World Bank

Sharief K A 1992 Valuation of irrigation water for different crops in the Gezira Scheme In *Workshop on irrigation water charges* Wad Medani Sudan International Irrigation Management Institute

Small L 1990 *Irrigation service fees in Asia* ODI/IIMI Irrigation Management Network paper 90/1e1 London Overseas Development Institute

Svendsen M T 1986 *Meeting irrigation system recurrent cost obligations* ODI/IIMI Irrigation Management Network 86/26 London Overseas Development Institute

Svendsen M T 1992 Recovery of irrigation costs through water charges In *Workshop on irrigation water charges* Wad Medani Sudan International Irrigation Management Institute

Water Committee 1988 *Land and water charge study* Khartoum Ministry of Agriculture

World Bank 1984 *Sudan agricultural sector survey* Report 1836a SU vol 2 3 Washington D C

Effect of Government Agricultural Market Interventions in Tanzania

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SUMMARY
Tanzania s economy is based on agriculture Since independence, the Tanzanian government has influenced the consumer and producer prices of goods through market interventions This study examines the effect of agricultural price and marketing intervention on the allocation of resources in Tanzania, which in turn, influences the level and efficiency of agricultural production

Through April 1986, the Tanzanian government maintained a relatively fixed exchange rate that overvalued the Tanzanian shilling Following that period, the government introduced regular adjustments to the exchange rate The devaluations have shifted government policy in favor of agriculture The implicit tax on agriculture that resulted from overvaluation was removed and the relative profitability of agriculture thus increased However, devaluing the currency increased the cost of imported agricultural inputs

The marketing system for agricultural products has been changed numerous times since independence Marketing boards and authorities were initially set to handle interregional and international trade However, these parastatal organizations have consistently operated at a deficit They are expected to pay the producer prices fixed by the government and to sell products to the consumers at fixed prices Inefficiencies and mismanagement have compounded the problems with the policies In 1984, the government began to recognize open-market trade and to decrease the role of the parastatals

Several different pricing strategies have been attempted, including offering pan-territorial or regional prices The agricultural producer prices in real terms declined from the mid-1970s until 1982/83 Pan-territorial pricing increased production in areas far from consumption centers Yet, no direct correlation exists between official prices and production levels At times when official prices were low, production increased to meet the demand on the parallel market

The production levels of coffee and cotton were affected by factors other than price, including climatic conditions and inadequate processing capacity In regions where maize competes with cotton for resources, the relative prices of the two crops influence which one farmers will produce

The open market should be encouraged, Tanzania has been moving in this direction However, the government should continue to play a role in providing infrastructure and operating a strategic food reserve

Agriculture dominates the Tanzanian economy It contributes 40% of gross domestic product (GDP) and over 80% of total exports Smallholder farmers are important producers and contribute 75% of total exports These exports include coffee cotton tea, tobacco sisal cloves cashew nuts and castor seed

Tanzania s agricultural sector provides food to rural and urban people supplies raw materials to industry earns foreign exchange and employs 90% of the country s labor force Much of the hired labor is used in estate production especially in the sisal industry Estates are also important producers of tea sugar coffee rice and wheat

Maize is the principal commercial foodcrop in Tanzania cassava and bananas are important subsistence crops Other important foodcrops include rice beans sorghum millet and sweet potatoes Smallholder farmers market about four-fifths of the cereals

Although private individuals produce most of the agricultural goods in Tanzania the government is actively involved in agricultural marketing The government fixes producer prices for the major cash and foodcrops and sets retail prices at the consumer level Officially crops are supposed to be purchased from the farms by cooperatives The marketing boards purchase the produce from the cooperatives and are responsible for exporting or marketing them interregionally

Although prices to agricultural producers have increased the foreign exchange-rate policies that the government has pursued have decreased real producer prices or left them unchanged By 1984 the weighted average official producer price was 46% below its 1970 level in real terms (World Bank 1986) In particular the prices received by farmers for export crops were only 50% of their 1970 level even though world prices of these crops at official exchange rates had risen 17% between 1970 and 1980

In Tanzania many government intervention policies were well intended but may have discriminated against agriculture These policies include less than optimal producer and consumer prices import duties on agricultural inputs indirect taxes physical controls on imports protection of infant industries and inefficient marketing boards

Despite the emphasis placed on agricultural and rural development by the 1967 Arusha Declaration, the Tanzanian agricultural sector is still unable to produce sufficient food and fiber to meet the demands of the expanding domestic and export markets Research studies by Hanak (1981), Manday and Wembah-Rashid (1981) and Mlambiti (1981) indicated that since 1967 there had been a falling production trend for all major crops except tea and tobacco The declining trend in production persisted despite the adoption of the Iringa Declaration in 1972, which emphasized the modernization of agriculture through intensive programs of improved technology—improved seed varieties, fertilizer, pesticides herbicides and mechanization—and modern husbandry practices

Despite these efforts the output of some export crops—notably cashew nuts cotton and pyrethrum—fell drastically during the 1970 s (World Bank 1986) During the same period, coffee production also stagnated By 1984, the volume of export crops sold by the marketing boards and authorities was 30% less than in 1970

This study examines the effect of agricultural price and marketing intervention on the efficient allocation of scarce resources and, thus, on agricultural production in Tanzania The specific objectives were to obtain a general description of the macroeconomic development of Tanzania and to analyze the impact of the various policy tools, especially pricing policy with respect to the agricultural output

The Arusha Declaration passed in 1967, set out a socialist development path for Tanzania However the impact of the declaration was felt only after 1972 when major institutional and organizational changes were made Thus this study focuses on the period from 1972/73 to 1988/89

Secondary data were collected to describe recent trends in the system of administered agricultural prices and output This data included figures on total exports and imports to determine the historical trend of the trade balance Other data included domestic consumer price indices international inflation indices exchange rates public institutions debt parastatals net profits and administered prices and output for coffee cotton and maize

The Macroeconomic Development of Tanzania

The inflation rate, exchange rate, and foreign-trade balance are key indicators of the impact of agricultural pricing They indicated economic imbalances during the second half of the 1970s, becoming more severe during the late 1970s and early 1980s These imbalances were manifested in galloping inflation rates, large and escalating balance of payment deficits, financial dependency due to worsening external debt and reserve position, and deteriorating aggregate growth rates

In the 1980s, the Tanzanian government started various adjustment programs to redress the structural disequilibrium The National Economic Survival Program was launched in 1981 and the Structural Adjustment Program was implemented from 1982 to 1985 Both programs aimed at revitalizing the agricultural sector through policy measures that would improve export performance However, the situation became worse as these measures were being implemented in 1982 In 1986, the IMF sponsored an Economic Recovery Program By 1989, the economic imbalances remained the export sector had not show any significant improvement, and the infrastructure had not been rehabilitated

Inflation and exchange rate

The National Consumer Price Index (NCPI) is Tanzania s official measure of living costs It was designed to measure price movements of goods and services purchased in regional urban centers The prices of imported inputs are excluded In addition the NCPI uses official food prices instead of the more widely relevant alternative market prices This limitation is compounded by the assumption that the nonavailable items have a minimal effect on the NCPI These limitations plus the fact that the NCPI is principally an urban index lead to an understatement of the true rise in rural living costs Open-market prices however, are not readily available

The NCPI indicates that domestic inflation rates in Tanzania increased from below 10% in the early 1970s to over 15% in the 1980s The rate for rural dwellers was probably higher The sharp rise in the inflation rate followed the war against Idi Amin in 1979 due to deficit financing of the national budget Inflation rises were also triggered by domestic borrowing to cover the losses incurred by inefficient parastatals

Tanzania's high domestic inflation contrasts with the lower inflation rates of the country's trading partners While prices in Tanzania rose by an average of 24% between 1975 and 1986, with a high of 44% in 1984, inflation in industrialized countries averaged about 7% annually

As inflation increases, it becomes necessary for the government to increase producer prices to maintain farmers' incentives to produce Given the importance of agriculture to Tanzania's economy, the government should fix prices well above the average inflation rate to provide incentives to farmers Annual price increases of less than 30% to 40% lead to disincentive effects In addition, since Tanzania is dependent on trade, the exchange rate should reflect the true value of foreign exchange in order to optimally allocate resources When the exchange rate is artificially low, import consumers—usually urban dwellers—benefit to the detriment of export producers—usually smallholder farmers

For many years, Tanzania maintained a relatively fixed exchange rate that overvalued the Tanzanian shilling This overvaluation encouraged the evolution of parallel markets for foreign exchange The average parallel-market rate was 1 94 times the official rate in 1973 and increased to 6 06 times in 1985 before it fell to 1 72 times in 1989 (table 1) Thus, at the official exchange rate, there was an excess demand for foreign exchange However factors other than the official exchange rates have affected the parallel-market rates These factors include decreases in export revenues, tight import controls, and capital outflows due to the fear of nationalization

The overvalued shilling resulted in lower prices on tradable goods relative to nontraded goods These relative prices encourage consumers to demand more tradable goods However, overvaluation also implicitly imposes a tax on exports and encourages farmers to reallocate resources to produce nontraded crops The index of the overall volume of Tanzania's crop purchased by the marketing boards for export between 1972/73 to 1985/86

Table 1 Comparison of official exchange rate and parallel market exchange rate

Year	Official (T Sh/US$)	Parallel market (T Sh/US$)	Ratio Parallel official
1972	7 20	15 45	2 15
1973	6 93	13 45	1 94
1974	7 18	14 00	1 95
1975	8 30	25 00	3 01
1976	8 36	20 40	2 44
1977	7 99	15 05	1 88
1978	7 45	11 75	1 58
1979	8 27	13 50	1 63
1980	8 22	20 00	2 43
1981	8 32	27 50	3 31
1982	9 52	32 60	3 42
1983	12 46	39 60	3 18
1984	18 11	60 00	3 31
1985	16 50	100 00	6 06
1986	51 72	170 00	3 29
1987	83 72	180 00	2 15
1988	97 20	195 00	2 00
1989	145 00	250 00	1 72

Sources Official rate Bank of Tanzania 1980 1991 parallel market rate Economic Research Bureau 1988a

showed a downward trend The fall in purchases of export crops was most pronounced for cotton sisal, cashew nuts and pyrethrum The production of coffee tea and cardamom remained relatively stable

Government activities have been financed by increasingly large fiscal deficits which have fueled inflation Although the deficits were acquired in part to provide resources to agricultural parastatals by accelerating inflation the government mitigated many of the benefits to the parastatals Since most government expenditures went to nonagricultural sectors of the economy the government may have taken more resources from agriculture through the inflationary tax than it provided in services

The Tanzanian shilling has been repeatedly devalued against currencies of the country s major trading partners The shilling was devalued by 10% in January 1979 12% in March 1982 20% in June 1983 and 26% in June 1984 Despite these adjustments the rate of exchange between the SDR currencies and the Tanzanian shilling changed by significantly less than the relative purchasing power they represented This situation necessarily leads to either a fall in real producer prices or increased losses incurred by parastatals Both occurred in Tanzania to the detriment of the export sector

Beginning in April 1986 the Tanzanian government introduced regular adjustments to the exchange rate By June the exchange rate was T Sh 40 per U S dollar compared to T Sh 16 at the end of March The government further devalued the currency by 33% against the U S dollar in 1987 In 1988, the value of the major currencies was realigned and the devaluation of the shilling against many European currencies became even more pronounced For example by December 1989, the value per pound sterling had fallen to T Sh 225 from T Sh 24 in December 1985 The value per U S dollar had fallen to T Sh 125 from T Sh 16, and the value per deutchmark had fallen to T Sh 70 from T Sh 7

The impact of devaluation, combined with the decision under the Economic Recovery Program to offer producers 70% of world-market prices, turned the terms of trade in favor of agriculture Devaluation removed the implicit tax on agriculture and raised its relative profitability However, devaluation also increased the prices of imported goods and services such as transportation equipment, agricul tural machinery, and fertilizer

Tanzania's foreign trade

Tanzania's official trade balance has been nega tive since 1972 (table 2) During the 1970s, the export performance of the agricultural subsector deteriorated significantly During this period a capital-intensive industrialization strategy was pur sued Imports grew due to the expansion of basic industries such as cement iron and steel Only in 1974 and 1975 can the growth of imports be at tributed to importing food The emphasis on importing capital goods meant that fewer intermediate and raw materials could be imported Thus, indus tries dependent on intermediate imports ran below capacity, and the per capita production of beer, textiles, cigarettes iron blankets, aluminum, and canned meat decreased

As a result of the poor and deteriorating balance of trade, foreign exchange was not available for essential imported inputs, such as agricultural im plements, pesticides, packing materials, processing equipment and parts fuel and transportation equipment This, in turn reduced the agricultural

potential and increased the pressure on foreign exchange requirements (Ndulu et al 1987)

In July 1984, a partial trade liberalization was introduced that allowed private traders to import incentive goods, such as sugar, salt, cement, and clothing, and sell them at market-clearing prices This action eradicated the long lines for scarce goods and for permits to acquire scarce goods The policy increased the profits for individuals who had access to foreign exchange and helped to reverse the flight of capital The resulting imports exceeded official export earnings in 1985 and 1986 (Ndulu et al 1987)

Tanzania's economy remains caught in a spiral of declining domestic production The effect of this decline on exports, the domestic supply of inputs and consumer goods and national revenue leads to a further decline in domestic industrial and agricultural production

The Tanzanian Agricultural Marketing System

The 1962 Agricultural Products Act instituted a three-tier, single-channel marketing system Under this system, the state became the only official buyer—a monopsonist The farmer sold produce to the cooperative society, which sold it to the cooperative union, which finally sold it to the marketing board or authority

After institutionalizing the single-channel system, the major problems included cooperatives' inexperience in marketing, lack of skilled personnel, dishonesty by some cooperative managers, and lack of democracy among cooperative members (Msambichaka, Ndulu, and Amani 1983, 55) In response to these difficulties, an inquiry into the cooperative movement and marketing boards was initiated in 1966 This inquiry led to the 1968 Cooperative Act, which increased government control over the cooperative movement In 1975, the Village Act was passed, and the village became the primary crop-procuring agent This resulted in the abolition of cooperatives in 1976 and the institution of a two-tier, single-channel marketing system The farmer sold crops to the village, which sold them to the marketing authority or board

Under the new system, the crop authorities were supposed to transport crops from village stores to consumption areas or to export points Because the parastatals were given increased responsibility without corresponding improvements in storage and transportation facilities, their overhead costs increased tremendously, the flow of information was interrupted, and financial discipline was difficult to enforce The inadequate emphasis on expanding the capacity to handle agricultural crops is reflected in the low share of accumulated infrastructure investments in the total assets portfolio In 1980/81, the government equity share was only 8% and continued to decrease with the increase in accumulated losses Due to low ratios of current assets to current liabilities, most parastatals relied heavily on National Bank of Commerce overdrafts

Table 2 Mainland Tanzania's foreign trade balance (T Sh millions)

Year	Exports	Imports	Trade balance	Balance as % of exports	Balance as % of GDP
1972	2 180	2 551	371	17	4
1973	2 545	3 433	888	35	8
1974	2 893	5 405	2 512	78	18
1975	3 120	6 389	3 269	105	19
1976	4 095	5 332	1 237	30	6
1977	4 364	5 995	1 631	37	6
1978	3 555	8 525	4 970	140	17
1979	4 439	9 093	4 654	105	14
1980	4 161	10 024	5 863	141	16
1981	4 609	9 660	5 051	110	12
1982	3 949	10 591	6 642	168	13
1983	4 734	10 153	5 419	114	9
1984	7 025	15 824	8 799	125	11
1985	4 719	16 483	11 764	249	11
1986	17 998	54 150	36 152	201	26
1987	31 813	96 275	64 462	203	33

Source Bank of Tanzania 1980 1991

These problems prompted the enactment of the 1982 Cooperative Act and the reinstatement of the three-tier single-channel marketing system in 1984 These policy changes were intended for villages that had already formed producer cooperatives but the policy was enforced in all villages

Thus far the Tanzanian government has maintained a single-channel marketing system But in the decades since independence the differing levels of centralization and the frequent changes of the marketing agents have destabilized farmers expectations and have discouraged production

Most parastatals do not have up-to-date accounts so it is difficult for them to ensure financial control Since the accounts are in arrears for several years it is impossible to account for the recent cost of government policies However, it is clear that the parastatals have not been profitable and have incurred large debts (table 3)

The capital structure of these parastatals was weak and they were forced to depend on the National Bank of Commerce for almost all of the funds necessary to carry out their activities The outstanding overdrafts were not covered by crop production which necessitated continual borrowing increasing the interest on the borrowed funds For example some of the National Milling Corporation's (NMC) financial problems were caused by its responsibility to supply staple foods at set prices Parastatals are squeezed between producers, who need higher prices to avoid a decline in their real income and urban dwellers who demand cheap food

The inefficiencies of the parastatals contributed to their accumulated losses Goods were lost in storage due to slack control over stocks avoidable transportation costs were incurred large balances and overdrafts were simultaneously maintained in current accounts sales were made to government departments and parastatals on credit cash balances were misappropriated by staff and many parastatals were overstaffed (Bank of Tanzania 1981 108) According to the responsibilities vested in these parastatals by the government purchasing crops was a service provided to farmers rather than a business Paying government fixed prices for crops and meeting the costs of handling transportation, and storage were regarded as legitimate and unavoidable expenses It is doubtful whether the parastatal management ever compared costs incurred with the expected revenues from crop sales (Bank of Tanzania 1981 108)

Table 3 Absolute and relative size of agricultural parastatal indebtedness, Tanzania March 1981

Parastatal	Overdraft (T Sh millions)	Overdraft as % of annual domestic purchases
National Milling Corporation	2 826	530
Tanzania Cotton Authority	654	160
Coffee Authority of Tanzania	602	90
Tobacco Authority of Tanzania	337	260
Tanzania Sisal Authority	297	100
Cashew nut Authority of Tanzania	187	100
Sugar Development Corporation	106	30
General Agr Products Export Co	58	60
Tanganyika Pyrethrum Board	42	210
Tanzania Tea Authority	25	20

Source Marketing Development Bureau 1981

For the financial year ending in 1987, there was a slight overall improvement in the performance of the major crop marketing boards The marketing boards for tea sisal, coffee and cashew nuts recorded profits However, the loss incurred by NMC rose from T Sh 1,808 million in 1986/87 to T Sh 3 700 million in 1987/88 Although the value of total sales rose by about 30% overhead costs more than doubled Since NMC sells primarily in the domestic market it did not benefit much from the devaluation of the shilling The cotton marketing board also incurred a loss of T Sh 2 715 million compared to a loss of T Sh 850 million incurred in 1985/86 Again much of the loss was caused by a high proportion of overhead costs, including interest payments to finance previous losses

Since the 1970s, food security has been a basic objective of the Tanzanian agricultural policy However, the NMC has accounted for only a minor portion of the food market

In the National Agricultural Policy of 1982 the government explicitly recognized the open marketing of major food commodities However, government policy has continued to assert control especially in periods of scarcity when exorbitant food commodity prices are regarded as the result of profiteering

The official recognition of open-market trade is reflected in the following government initiatives

- the 1984 removal of the 500-kilogram restriction on interregional movements of food

- recommendations by a special Task Force on Food Distribution that recognized open-market trading (published in 1986)
- the 1987 abolition of the regulation requiring permits to transfer food within Tanzania
- the 1987 decontrol of pricing and marketing of drought-resistant staples—millet, sorghum, and cassava—at the cooperative level
- the change by 1988 so that NMC was no longer the buyer of last resort but instead was expected to act as a commercial enterprise, trade in maize was decontrolled at the cooperative union level so that private traders could officially trade in maize at and above this level

Agricultural Price Policy

Agricultural price policy influences growers incentives to produce for the market Agricultural policy in Tanzania also determines the costs to crop marketing authorities and boards, and these costs determine their success or failure as businesses

Before the mid-1970s, the Tanzanian government s primary concern was to reorganize the rural population into villages Price policy did not feature significantly in any major policy statement on agriculture Currently in Tanzania, the initial producer price recommendations are the responsibility of the Marketing Development Bureau (MDB) of the Ministry of Agriculture In reviewing prices, MDB tries to balance four aspects of agricultural prices

- budgeted producer earnings per person-day
- break-even retail prices
- import-export parity
- official procurement levels

The ministry and an inter-ministerial committee review the recommendations and present final recommendations to the Economic Committee of the Cabinet However it is not uncommon for the cabinet to adjust the recommended prices Most of the foodcrops—maize, rice, wheat, sugar, and drought-resistant crops—are consumed domestically thus, the government can easily influence producer and consumer prices For export crops—coffee cotton pyrethrum, sisal, tobacco, tea, and cashew nuts—the government can influence producer prices but cannot control consumer prices that are determined by world-market supply and demand

Official producer prices in nominal terms

Since World War II producer price policies in Tanzania have consistently influenced production and marketing but often have had unintended results For example, before 1970 agricultural pricing policies did not consider inter-crop price ratios The into-store price of the food-crop boards was determined by subtracting procurement and distribution expenses from the estimated trend of import-parity prices Producer prices were determined after deducting the expenses incurred by the cooperatives Producer prices for the export crops were similarly determined the relevant costs were deducted from the established trend of export proceeds Because domestic prices were relatively stable, the government attempted to hold grower prices (except for coffee and sisal) stable with occasional increases despite erratic changes in export- and import-parity prices (table 4) This price policy resulted in surpluses or deficits for export crops and domestic prices unrelated to international prices for foodcrops, especially maize rice and wheat

From 1970 to 1973, the Agricultural Price Coordination Committee tried to consider relative prices and the incentive impact of some prices However, local levy and cooperative charges were increased whenever central taxes were reduced or other measures were introduced to increase producer prices

During 1974/75 to 1979/80, it is difficult to identify a coherent pricing policy No measures were taken to control the costs of operations by the export-crop marketing boards or authorities For drought-resistant crops, the policy adopted in 1975/76 following low production in 1974 and 1975 produced massive sales to NMC The policy was designed to encourage production of these crops for consumption during drought periods However, commercial sales increased tremendously and created problems of disposal and sale for NMC

Table 4 Announced producer prices for maize cotton and coffee (T Sh/kg)

	Maize		Coffee		Cotton	
Year	Premium	Non premium	Mild arabica parchment	Robusta dry cherry	Grade A	Grade B
1971/72	0 24	0 24	3 48	1 40	1 10	0 55
1972/73	0 26	0 26	3 95	1 40	1 13	0 60
1973/74	0 33	0 33	3 20	2 05	1 13	0 60
1974/75	0 55	0 55	4 00	2 05	1 50	0 65
1975/76	0 80	0 80	6 00	3 30	2 00	1 00
1976/77	0 80	0 80	6 00	3 30	2 00	1 00
1977/78	0 85	0 85	9 00	4 90	2 30	1 15
1978/79	0 85	0 85	8 00	3 75	2 40	1 20
1979/80	1 00	1 00	8 00	3 75	3 00	1 30
1980/81	1 00	1 00	9 00	3 50	3 20	1 50
1981/82	1 50	1 50	9 00	3 50	3 70	1 70
1982/83	1 75	1 50	12 00	6 30	4 70	2 50
1983/84	2 20	1 90	16 80	6 80	6 00	3 20
1984/85	4 00	2 50	23 50	12 90	8 40	4 50
1985/86	5 25	3 50	28 20	16 10	13 00	7 00
1986/87	6 30	4 20	50 75	29 00	16 90	9 10
1987/88	8 20	4 20	66 00	37 00	19 45	9 10
1988/89	9 00		90 00	51 00	22 35	10 00

Source Marketing Development Bureau 1989

A pan-territorial pricing system was introduced in two stages The maize shortage of 1974 led to the abolition of the previous division of the country into preferred and deterred regions for maize prices With the abolition of cooperatives in 1976 the NMC price became the farm-gate price—storage and transportation costs fell on the NMC

The second stage of pan-territorial pricing was introduced for all crops at the beginning of the 1976/77 marketing year The two explicit objectives for introducing pan-territorial pricing were

- to equalize income differentials between farmers operating from different regions
- to increase national agricultural output by stimulating production in remote areas through price incentives

Before 1976 the costs of cooperative unions were reflected in the prices passed on to the producer These costs included transportation charges which had a special impact on the farm-gate price of high-bulk low unit-price commodities like maize and cassava

The introduction of pan-territorial prices for agricultural products and production inputs increased the officially marketed surplus from areas far from consumption areas such as Rukwa and Ruvuma regions These regions are not served by railroads and due to lack of maintenance road transportation can cost as much as seven times the equivalent railway cost The higher cost of road transportation involves many imported inputs such as fuel, spare parts tires and vehicles which drain the country s foreign reserves

For the areas where transportation costs were low pan territorial pricing taxed farmers by an amount equal to the difference between the uniform transportation rate and the actual low transportation cost On the other hand, areas with high transportation costs were subsidized by an amount equal to the difference between the actual high and the uniform low transportation rate

In 1982/83 regional maize pricing was reintroduced with some changes These regional prices took into consideration the comparative advantages in production of different regions, but did not include transport to-market cost differentials Thus regions assumed to be conducive to maize production received a premium price and regions with less favorable climatic conditions received a lower price For example the premium maize price was T Sh 8 20/kg for the 1987/88 marketing year and the nonpremium price was T Sh 4 20/kg The nonpremium price was so low that cooperatives in those regions complained that they were unable to purchase any maize locally and were forced to purchase maize from other regions at a cost above the premium price

Table 5 Official producer prices in real terms for maize, cotton, and coffee T Sh/kg (deflated by national consumer price index, 1988/89=100)

			Coffee			
	Maize		Mild arabica	Robusta dry	Cotton	
Year	Premium	Non premium	parchment	cherry	Grade A	Grade B
1971/72	7 59	7 59	110 1	44 3	34 8	17 4
1972/73	7 60	7 60	115 5	40 9	33 0	17 5
1973/74	8 39	8 39	81 3	52 1	28 7	15 2
1974/75	10 33	10 33	82 7	42 4	31 0	13 4
1975/76	14 25	14 25	106 9	58 8	35 6	17 8
1976/77	13 05	13 05	97 9	53 8	32 6	16 3
1977/78	12 43	12 43	131 6	71 7	33 6	16 8
1978/79	10 71	10 71	100 8	47 3	30 2	15 1
1979/80	9 87	9 87	79 0	37 0	29 6	12 8
1980/81	7 83	7 83	70 5	24 4	25 1	11 7
1981/82	9 41	9 41	56 5	22 0	23 2	10 7
1982/83	8 19	7 02	56 20	29 5	22 0	11 7
1983/84	8 50	7 34	64 9	34 0	23 2	12 4
1984/85	11 11	6 94	65 3	35 8	23 3	12 5
1985/86	11 37	7 58	61 0	34 9	28 1	15 2
1986/87	10 30	6 87	83 0	47 4	27 6	14 9
1987/88	10 26	5 25	82 6	47 2	24 3	11 4
1988/89	9 00		90 0	51 0	22 4	10 0

Source Marketing Development Bureau 1989

Official producer prices in real terms

There was a general decline for all real agricultural producer prices from the mid-1970s until 1982/83 (table 5) Producer prices for the predominant staples—maize, rice, wheat, and beans—peaked in 1977/78, and by 1982/83, prices had fallen 30% in real terms Between 1983/84 and 1985/86, food production and purchases by NMC increased so much that in 1986/87 prices were deliberately reduced to encourage export crop output

The real producer prices for maize peaked in 1975/76 By 1982/83 prices had fallen by 34% for premium and 44% for nonpremium prices During the following 3 years, the real premium price increased by 39% and by 1985/86 it had recovered to above the level of 1978/79 Subsequently, the real price of maize declined The increase in the real price of maize during 1983/84 to 1985/86 reflected the government s desire to encourage food production and to attract additional supplies to the official marketing system

For perennial export crops, the real price index peaked in 1977/78 and then fell by 53% by 1982/83 The index stabilized until 1986/87 when it rose by 33% following large increases in the producer prices of perennial export crops

For annual export crops—cotton, tobacco and castor seed—the price index peaked in 1971/72 Since then the index has been on a downward trend From 1970/71 to 1983/84, producers experienced a 40% decline in real prices

Nominal producer prices for cotton increased steadily over the past two decades However in real terms, prices peaked in 1975/76 and declined until 1982/83 Real producer prices increased slightly in 1985/86, taking prices to their highest level in 5 years Even at this level, however, real prices were still only 75% of their level of 10 years earlier In 1985/86, world market prices for cotton began to decline The Tanzania Cotton Marketing Board incurred enormous losses and it was difficult to maintain producer prices in real terms In 1986/87, after a large devaluation of the Tanzanian shilling, producer prices were increased by 30%—a marginal decline in real terms In 1987/88 producer prices of cotton were increased by 15%—a decline of 8% in real terms For the 1988/89 marketing year, producer prices were set at T Sh 22 35/kg for a grade A and T Sh 10 00/kg for grade B—a rise of 15% for grade A and 10% for grade B Under the inflation targets set for the Economic Recovery Program, the price of grade A was supposed to be maintained in real terms while the price for grade B would decline by 40% in real

terms However grade A prices fell by 8% and grade B prices by 12%

For coffee although substantial nominal price increases have been registered since 1982/83 the real value of the producer prices has been less encouraging The advance producer prices of both Mild Arabica Parchment I and Robusta Dry Cherry in 1982/83 were less than half the 1977/78 prices in real terms The efforts to turn around this declining trend succeeded in 1983/84

The Economic Recovery Program s objective of increasing producer prices by 5% in real terms was not achieved for maize or cotton For coffee it was well above the target except for 1987/88 when real prices declined by about 0 5% for both Arabica and Robusta

Relationship between official prices and production

An examination of NMC yearly purchases for 1970/71 to 1973/74 shows that six regions did not contribute anything However for 1976/77 to 1979/80 each region contributed something Consequently the Arusha Dodoma Iringa and Kilimanjaro branches of NMC together accounted for 84% of the total purchases from 1970/71 to 1973/74 but only 59% from 1976/77 to 1979/80 On the other hand Rukwa and Ruvuma which together contributed only about 0 5% in the first period accounted for as much as 16% in the latter period

The relative shares of the different regions changed significantly during the two periods because of a change in the policy governing producer prices A uniform producer price for maize was instituted in 1974/75 during the previous 2 years separate prices existed for priority and nonpriority areas Thus pan-territorial pricing increased sales in Rukwa and Ruvuma regions which are far from the consuming centers

The official price of maize increased in real terms from 1971/72 to 1975/76 However for NMC these were deficit years The period was characterized by low domestic purchases and high imports Despite low purchases by NMC maize production increased from 889 000 tons in 1972/73 to 1 449 000 tons in 1975/76

Official maize prices declined in real terms from 1976/77 to 1983/84 but maize production increased except for the drought years of 1977/78, 1981/82 and 1982/83 The official purchase price of maize was not the only determinant of production Food shortages and the low official producer prices resulted in high parallel-market prices that encouraged increased production However, consumers were forced to rely on the parallel market because the official consumer prices were not enforced In 1986/87 despite a deliberate decrease of official prices to encourage export crop production, total maize production reached its highest level at about 2,350 000 tons In 1987/88, maize production fell slightly due to poorly distributed rains during most of the season However, despite this fall and a slight decline in real official producer prices production exceeded 2 million tons and Tanzania was defined as self-sufficient in maize

Coffee has been Tanzania s most valuable export product since the mid 1970s The trend in production levels since 1971 has been irregular from year to year and from region to region The magnitude of variation in coffee production from region to region in a given year suggests that national pricing policies have been less important than the growing conditions in each area including weather, pests, diseases and the availability of inputs and transportation facilities

The southern regions of Mbeya and Ruvuma are the only areas with a steady increasing trend in coffee production since 1972/73 In the western regions of Kagera Kigoma and Mara Robusta coffee production peaked in 1979/80 and declined until 1985/86 The northern Arabica production areas of Kilimanjaro, Arusha and Tanga maintained fairly constant production levels until 1988/89 when production rose significantly

The lagged total coffee payments received by the farmer and the announced advance price had a similar impact on total coffee production The Robusta advance price elasticity of supply was 0 06 while total price elasticity of supply for Robusta was 0 05 For all Arabica producers both price elasticities were 0 05 for the southern regions, the advance price elasticity was 0 32 and the total price elasticity was 0 30 The significant variation in coffee production in the south can be explained by coffee prices, whereas in the other areas, especially

Kilimanjaro, Arusha, and Tanga, variations in coffee production must be explained by other factors

Cotton production decreased during most of the 1970s and early 1980s Peak production was reached in 1972/73 when 225,700 tons of seed cotton were purchased by the marketing board By 1985/86, production had fallen to only 107,800 tons The major production constraint for cotton was inadequate storage, transportation, and processing capacities

In some regions, including Mwanza and Morogoro maize competes with cotton for resources Therefore, the relative prices of the two crops determines how farmers allocate their scarce resources The official producer price for seed cotton in 1971/72 was 4 58 times the official producer price of maize, in 1974/75 it was 3 times higher and fell to 2 69 in 1982/83 The relative prices were erratic between 1982/83 and 1986/87, finally falling to 2 37 in 1987/88 Relative official prices have made cotton less attractive to farmers over the last two decades Moreover, the increasing importance of unofficial markets for grain has made a drastic difference in farmers' expected returns from maize relative to returns from cotton For example, the average open-market maize prices in 1986/87 were T Sh 8 61 in Mwanza and T Sh 10 37 in Morogoro, making the cotton/maize price ratio only 1 96 and 1 63, respectively

Economics of Maize Production

It is widely believed that Tanzania has a comparative advantage in producing cotton and coffee but it is less clear whether Tanzania also has a comparative advantage in maize production

Some standard economic measures provide an indication of the economic potential of maize production These measures include net economic benefit (NEB), which compares economic benefits to economic costs domestic resource cost (DRC), which measures the cost in terms of domestic currency of earning or saving a unit of foreign exchange, and the effective protection coefficient (EPC), which measures protection provided to domestic producers

To calculate these measures, import- and export-parity prices for maize must be estimated Researchers from the Economic Research Bureau of the University of Dar es Salaam calculated these measures based on World Bank projections of international maize prices in 1988 and 2000 (in constant 1988 terms) In the base year, they used an exchange rate of about T Sh 100 per U S dollar To test the sensitivity of the results to exchange-rate levels, a lower exchange rate of T Sh 125 per U S dollar was also used The import-parity price calculations indicated that the higher the transportation cost to Dar es Salaam, the higher the difference between import-parity prices to the producer and the consumer

Since Tanzania has the physical potential to increase maize production, a surplus could be economically exported if producer prices were set at an appropriate level With the conditions prevailing in 1988, Tanzania had an economic advantage in substituting for maize imports but no comparative advantage in exporting maize to the world market However, using the World Bank price projections of about US$137 per ton by the year 2000 (in 1988 terms) and an exchange rate of T Sh 125 per U S dollar, the actual price of maize in constant terms could either be increased or maintained for 11 regions and reduced for the other 8 regions (table 6)

Expansion of production cultivated by hand is not economical Ruvuma has a comparative advantage in substituting for maize imports but only under improved hand cultivation Given transportation and other marketing costs, Ruvuma maize is not competitive in the world market The sensitivity analysis of the results for Ruvuma showed that to be able to achieve a DRC of 0 8—which more or less confirms comparative advantage—the exchange rate would have to be about T Sh 155 per U S dollar

Conclusions and Recommendations

Marketed output does not depend solely on real producer prices other factors affect agricultural performance

- Weather is not affected by policy When the weather is unfavorable, supplies become scarce and official prices do not adjust immediately Open-market prices rise, and free trade takes a bigger part of the farmers surplus This leads

Table 6 Net economic benefit (NEB) effective protection coefficient (EPC) and domestic resource cost (DRC) for maize (T Sh 000/ha)

	Import parity (1988 prices)			Export parity (2000 prices)		
	NEB	EPC	DRC	NEB	EPC	DRC
			Dodoma			
Hand cultivation						
Low potential areas	1 20	0 63	1 38	1 80	0 83	1 51
High potential areas	1 00	0 66	0 82	0 20	0 85	1 03
Animal traction	3 90	0 61	0 57	2 00	0 82	0 81
			Arusha/Kilimanjaro			
Hand cultivation	3 20	0 67	0 68	1 10	0 87	0 91
Animal traction	11 80	0 60	0 38	6 40	0 78	0 70
Mechanized cultivation	10 30	0 41	0 43	4 60	0 56	0 78
			Mwanza/Shinyanga			
Hand cultivation	0 40	0 70	0 90	0 60	0 93	1 11
Animal traction	2 60	0 68	0 71	0 50	0 92	0 95
			Ruvuma			
Hand cultivation	0	1 02	1 00	2 30	1 51	1 23
Improved hand cultivation	5 50	0 99	0 67	0 90	1 75	1 00

Source Economic Research Bureau 1988b

Note Exchange rate was calculated at T Sh 125 = US$1 00

to a fall in purchases by the government and imports become necessary to feed the urban population

- The availability of arable land affects agricultural performance For example, in Kilimanjaro land is a constraint to production, an increase in maize prices may not necessarily increase production unless it is done at the expense of coffee or other crop production or unless the yield can be increased through better crop husbandry
- The lack of agricultural inputs—seeds, fertilizer and insecticides—constrains production
- Production technology also affects production levels Hoe cultivation limits the amount of land to be farmed Even if prices rise sharply farmers would not be able to significantly increase production
- The Tanzania transportation system has experienced a considerable cost increase due to bad roads and the oil crisis

This report has focused on macroeconomic development and agricultural price policy and their effects on production patterns and market development The overvaluation of the Tanzanian shilling lowered the price of tradable goods relative to nontradable goods This, in turn, encouraged producers to produce nontradable goods rather than export crops while consumers have tended to demand more traded goods including imported food

The introduction of regional prices for maize, without taking into account real transportation costs may have had the same negative effects as the pan-territorial pricing system However, official recognition of the importance of an open market was a move in the right direction

Tanzania has an economic advantage in becoming self-sufficient in the production of maize The analysis also indicates that production increases could be economically achieved by improving farming systems Thus the long-standing objective of self-sufficiency in the production of basic food stuffs is economically sound However, self sufficiency in the production of basic foodstuffs should not be achieved at the expense of export crop production

Government intervention in setting food prices and marketing agricultural products may be necessary for the following reasons

- Unusually favorable weather may result in substantially reduced market prices
- Owing to lack of finance and storage and transportation facilities private traders may not be in a position to compete and this may lead to poor availability market information This situation could permit a few traders to exploit producers and consumers

- Private traders may not be willing to operate in remote areas like Rukwa and Ruvuma
- Emergency situations may occur, thus, the government should operate a strategic food reserve

To develop an efficient pricing system in Tanzania NMC should guarantee a floor pan-territorial price based on the export-parity price to the producers in remote regions This would enable NMC to trade in any region without a loss NMC should be designated as the manager of a strategic food reserve Stocks should be released when price exceeds the import-parity price to the consumer

The marketing boards and cooperatives should not be allowed to operate at a loss They should be forced to operate on a commercial basis by competing with private traders An institutional structure should be established to monitor and evaluate the performance of these parastatals

The private sector should be encouraged however, the government should take the initiative to improve the marketing infrastructure including roads, credit, the availability of spare parts and storage facilities

Literature Cited

Bank of Tanzania 1981-1991 *Economic and operations report* Various issues Dar es Salaam Government Printer

Bank of Tanzania 1981 *Twenty years of independence (1961 1981) A review of political and economic performance* Dar es Salaam Government Printer

Economic Research Bureau 1988a Economics of Tanzanian cereal production *Tanzania Economic Trends* 1(3) 45-53

Economic Research Bureau 1988b Macroeconomic performance *Tanzania Economic Trends* 1(3) 4-7

Hanak E E 1981 National economic crisis and the formulation of research priorities Linking farming systems research with macroeconomic imperative In *Proceedings of the Conference on Farming Systems Research in Arusha Tanzania* ed P Anandajayasekeram B Ndunguru and I Lupanga 43-55 Morogoro Tanzania Adventist Press

Manday E and R Wembah Rashid 1981 The political economy of cash crop production in Tanzania Paper delivered at a workshop on 15 Years After Development in Tanzania Kilimanjaro Hotel Dar es Salaam October 10-14

Marketing Development Bureau 1981 *Price policy recommendations for the 1982/83 agricultural price review summary* Dar es Salaam Ministry of Agriculture and Livestock Development

Marketing Development Bureau 1989 *Annual review of agricultural marketing* Dar es Salaam Ministry of Agriculture and Livestock Development

Mlambiti M E 1981 Problems of food production Who is to be blamed? Paper presented at the annual conference of the Agricultural Society of Tanzania held at Morogoro June 1-2

Msambichaka L A B J Ndulu and H K R Amani 1983 *Agricultural development in Tanzania Policy evaluation performance and evolution* Bonn Germany Freidrich-Ebert-Stiftung

Ndulu B J H K R Amani N H I Lipumba and S M Kapunda 1987 *Impact of government policies on food supply in Tanzania* Dar es Salaam Economic Research Bureau University of Dar es Salaam

World Bank 1986 *World development report* New York Oxford University Press

Foreign Assistance and Agricultural Research and Development in Tanzania: Some Policy Issues

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SUMMARY

This study examines Tanzania s experiences in administering technical cooperation resources Four donor-supported teaching and agricultural research institutions are studied the Mbegani Fisheries, Uyole Agricultural Center, and the Faculty of Forestry and the Faculty of Veterinary Medicine at the Sokoine University For purposes of the study, technical cooperation is construed as a major instrument in international development cooperation that aims at enhancing human and institutional capacities through the transfer and utilization of knowledge, skills, and technology

Three broad lessons can be drawn from the study First, foreign aid, like most other aspects of international relations, was largely governed by the structural power patterns in the global system It is argued that the economic inequalities and power imbalances inherent in the international aid regime invariably influence the behavior of the actors on both sides of the aid process Second, the nature of the state, its institutional capacity, and the type of developmental strategy pursued significantly determine the quantity and indeed quality of its international transactions Third, and as a result of the above arguments, it is apparent that less effective policies and weak policy instruments were more likely to lead to dislocating aid consequences on recipient states In fact, weak recipient states are likely get ever weaker because of the aid overload

The study demonstrates that Tanzania did not generally succeed in maximizing the exploitation of technical cooperation resources to achieve its professed development objectives The major explanation for Tanzania's poor performance was the incapacity of the state to design comprehensive development policies and to establish effective and efficient institutional frameworks for policy management As a result, technical cooperation delivery tended to be not only ad hoc and laissez-faire but also allowed donors to impose their own preferences on the economy Under those inauspicious circumstances therefore, the loosely coordinated foreign resource flows led to neither sustainable institutional capacity building nor to cumulative technology transfers

Another equally compelling explanation flows directly from the first Aid development policies in Tanzania were unusually silent on how to carry out technical cooperation needs assessment The low levels of technical cooperation effectiveness in Tanzania are largely attributed to imprudent economic planning and management Too often, aid-supported projects were left to donor management and control, rarely were they systematically incorporated into the annual development budgets Not surprisingly, when the time for their transfer to national institutions came, the Ministry of Treasury was caught unawares As a

result projects like the Mbegani Fisheries and the Uyole Agricultural Center were left to simply decay as donors finally withdrew their aid support

It is recommended that the future development policies of Tanzania should unambiguously articulate the role of foreign assistance in general and that of technical cooperation in particular in the national development effort Such policies should further put in place capable and efficient institutional arrangements to manage national development programs At the same time those institutions should be capable of providing a credible and sustainable countervailing force to the overwhelming power of aid donors

The aim of this research was to examine Tanzania s experiences in acquiring technology through technical cooperation arrangements For purposes of this study, technical cooperation is construed as an instrument of international development cooperation that seeks to enhance human and institutional capabilities through the transfer adaptation and utilization of knowledge skills and technology It is argued that because of the fragile institutional and structural capacity of the state Tanzania has not generally succeeded in maximizing the exploitation of technical cooperation resources to achieve its policy objectives It is further argued that for a long time the government of Tanzania s macroeconomic development policies did not incorporate a clear and comprehensive technical cooperation policy framework [1]As a result of this major shortcoming technical cooperation delivery in the country tended to be ad hoc and laissez faire Moreover reliable institutional mechanisms for identifying and programming realistic national technical cooperation needs have remained relatively weak It is therefore argued that ill-planned and poorly coordinated resource transfers have not led to sustainable institution capacity building nor to cumulative technology transfer Finally it is argued that at a project level there are no sound systems for transparent and flexible management of foreign assistance resources The state s regrettable abdication of its policy management responsibilities to donors is a result of a vacuum in the local administration and control systems (Mutahaba 1989 Kleemeier 1982 Nkonoki 1991)

The structural dependency theory in international political economy provides valuable insights to explain the aid process The theory seeks to specify the relevant power assets and interdependencies between the actors in question The power resources that are relevant to the aid process are finances technology and the policy inputs of donors These resources can be translated into effective influence or compliance through the imposition of costs or by conferring benefits to the recipient In this case the theory assumes unequal distribution of power and wealth between donors and recipients When a donor supplies its recipient with large amounts of important goods that cannot be easily replaced at tolerable costs then the donor is in a position to influence the behavior of the recipient In other words power springs from asymmetric interdependencies Inequality between actors in the aid process is the necessary condition for the actual exercise of influence over behavior Moreover because of the unequal distribution of power resources donors are able to exploit the recipient s dependence for purposes of structuring long term relationships in areas like trade, investment and security

The structural dependency theory further assumes the donor has a disproportionate influence on the very content of the aid relationship The written and unwritten rules principles and norms, and procedures that govern aid relationships are equally asymmetrical, reflecting the inherent power imbalance All things being equal the theory predicts that the internal economic and social progress of recipient nations will be influenced and largely limited by constraints imposed by donor nations (Poulantzas 1974, Jalee 1968, Ake 1979)

However a variety of capabilities that a recipient state and its institutions deploy are likely to make a significant difference in such international

[1] Scattered policy statements about technical cooperation in the Arusha Declaration (1967) and thereafter were never woven into one coherent policy nor were there any serious attempts to operationalize them into a set of strategies for what assistance to seek and what priority sectors to target or how to establish a transparent management system Only recently has the Government been sensitized into seriously working toward establishing a technical cooperation policy framework (UNDP 1989)

transactions These are the political, technical, and organizational capabilities of the recipient state and its lower institutions The ingredients of those capabilities would be demonstrated, among other things, by its possession of a trained and experienced bureaucracy able to formulate and effectively implement clear and comprehensive national policies Supported by stable and reliable institutions, the envisaged policy framework would distill national technical cooperation objectives, prioritize the needs, and, in each case, target the beneficiary populations Indeed those capabilities would naturally translate into an effective countervailing force to safeguard the core national interests In this sense therefore, the chances of donors imposing low-priority technical cooperation projects or transferring inappropriate technologies would be substantially reduced, as would the frequency of projects and programs lacking sustainability To be sure, those critical institutional capabilities develop unevenly across economies and sectors

However, studies by Morss (1984) and Doornbos (1990) have advanced a compelling argument that in fact, donor and project proliferation in Africa tends to contribute significantly to institutional erosion and decay They claim that the overwhelming pressure of donors diverts African governments from establishing national policies and priorities to simply trying to please donors in order to acquire additional aid Under the pretext of 'policy dialogue,' such governments have ended up accepting ready-made policy packages already agreed upon by the major donors

This paper examines the size, magnitude, and role of technical assistance to Tanzania, it provides case studies of the Mbegani Fisheries Development Center and the Uyole Agricultural Center, arguing that in the absence of a comprehensive policy framework, implementation strategies and effective executing national institutions, the impact of technical cooperation is likely to be marginal at best and destructive at worst, and it presents the facts behind two success stories

Technical Cooperation and Its Distribution in Tanzania

During the mid-1980s sub-Saharan Africa received an estimated US$4 billion a year of technical cooperation and about 70,000 to 100,000 expatriates worked on a variety of projects (Wallace 1990, 27) There is, however, a growing skepticism in the literature about the cost-effectiveness of technical cooperation and its mode of delivery It is argued that not much success has been recorded in institutional capacity building nor in human resource development in critical scientific and policy management areas It is further argued that technical cooperation delivery and administration is donor-driven and that the recipient government positions have usually been reactive rather than proactive As a consequence, the overall impact of technical cooperation in sub-Saharan Africa has been disappointing (Green 1973, Mushi and Kjekshus 1982, Baskin 1985)

Moreover, in Africa there has been a growing disillusionment with the role of technical cooperation personnel While the number of highly educated Africans has been increasing, the volume of technical cooperation personnel has also been rising These lords of poverty have absorbed 70% to 80% of the total technical cooperation resources in Africa (Bernis 1990, 10) Too often, technical cooperation experts have been engaged in areas where nationals with far superior professional qualifications and even richer grassroots experience exist Such disturbing yet common situations have led some critics to suggest there are hidden agendas on both sides of the aid relationship (Hayter 1970, Bhatt 1980, Payer 1982)

Above all, some official misconceptions about technical cooperation have also heavily contributed to its gross ineffectiveness in several African countries Technical cooperation resources are invariably misconceived as gifts In other words, they are taken to be costless development funds that are simply not to be repaid Indirect costs linked to technical cooperation use are seldom considered (Bernis 1990, 6) It is precisely because of this mistaken notion that some governments have tended to accept any of these gifts" regardless of their importance in the national development plans and priorities Little effort is usually made to carefully assess, say, the professional competence of the technical cooperation personnel, the rigor of a counterpart training programs, or the appropriateness of the technology packages imposed on illiterate peasants (Bagachwa and Rugumamu 1991) To

Table 1 The volume of technical assistance to Tanzania, 1980-89 (US$ million)

Year	Total aid	Technical cooperation	Tech cooperation vs total aid (%)
1980	666	233	35
1981	701	229	33
1982	684	178	26
1983	593	209	35
1984	557	216	39
1985	486	200	41
1986	680	260	38
1987	814	244	30
1988	905	250	28
1989	906	293	32

Sources OECD 1982 1984 UNDP 1987 1988 1989

be sure, misconceptions of this kind have not helped to enhance the positive impact of technical cooperation

Tanzania is one of the major aid recipients in sub-Saharan Africa Between 1970 and 1990, it received an estimated US$13 billion in foreign assistance, accounting for about 80% of net official flows of external capital In 1975/76 for example, the country was the third largest aid recipient in the region receiving US$302 million in Official Development Assistance (ODA) or about 1 6% of the disbursed aid In 1980/81 and 1987/88, Tanzania ranked second receiving US$666 million and US$814 million, respectively from the ODA disbursed Funds Over a 10-year period, the share of technical cooperation resources in the total aid flows averaged about 33% (table 1)

There are at least two significant policy implications First a relatively large proportion of the aid that was extended to Tanzania was allocated to the technical cooperation personnel Rather than strengthening the institutional capacities of the recipient state, donors went out of their way to create parallel organizations to run their aid-assisted projects Second, for over a decade, the government of Tanzania seems to have been comfortable with such arrangements Bureaucrats in Tanzania and many African countries have out of self-interest, tended to perceive technical cooperation personnel as an easier channel of communication with donor agencies In other words they have been seen as interpreters and facilitators with aid agencies Above all technical cooperation personnel bring with them scarce commodities like computers, cars and the like, which eventually benefit the recipient bureaucrats (Rugumamu 1992, 80)

A closer inspection of the composition of technical cooperation personnel in Tanzania, reveals that a substantial percentage of them were engaged in operational activities where nationals with higher academic qualifications and experience existed Therefore, foreign assistance tended to create employment for donor countries rather than enhancing institutional capacities of the recipient country (Rugumamu 1993) Aid-tying of this sort defeats its very purpose of capacity building These observations corroborate our initial assumption concerning the hidden agendas on both sides of the aid relationship

Between 1986 and 1989 the total technical cooperation resources to Tanzania increased from US$260 million to US$293 million with a low of US$244 million in 1987 During the same period, according to the same UNDP (1990 12) sources, the number of technical cooperation projects recorded more than doubled—increasing from 420 to 979 projects supported by 60 donors However, as it has been documented elsewhere (Cassen 1986, Lipton and Toye 1990) the effect of a large number of donors works in two opposing directions On the one hand for countries with strong technical and organizational capacities like India or South Korea, a large number of donors may be a blessing in disguise Cassen (1986 223) has noted there may be some benefits in multiplicity when it widens the recipient s choices and permits a range of innovations that might not arise if only a few agencies were in the field On the other the effect of a large number of donors m ıy lead to aid overload if the administrative capacity of a recipient government is relatively weak In Tanzania the proliferation of donors strained the organizational capacity of the government to a point where the situation did not permit any effective learning to take place in the field of aid management

However over the same period, technical cooperation resources were disproportionately distributed among sectors Since the introduction of structural adjustment programs aid composition and distribution in Tanzania has reflected priorities largely determined in Washington The general development policy and planning sector received an average of 24% over a 4-year period (table 2) This reflects the importance that came to be attached to policy management Technical cooperation experts

Table 2 Sectoral distribution (%) of external assistance to Tanzania, 1986-89

Sector	1986	1987	1988	1989	Avg 1986 89
General development issues policy and planning	16	37	30	12 9	23 9
Transport and communications	13	16	18	20 3	16 8
Agriculture forestry and fisheries	13	15	15	8 0	12 7
Industry	8	10	13	19 7	12 6
Health and water	5	9	11	5 7	7 6
Education	5	3	5	7 3	5 0
Others	40	10	8	26 1	21 0
Total	100	100	100	100	100

Source UNDP 1987 1988 1989

flooded major policy-making institutions in order to ensure that the policy reform measures were followed through The agricultural sector, supposedly the nerve center of the economy, was allocated 13% of the disbursed funds The education sector received only 5% This is a clear manifestation of a poor priority ranking procedure in the national planning system Understandably this kind of an oversight can only happen in countries where donors are left relatively free to pick and choose where to invest their resources

The underlying assumption of technical cooperation is that the application of improved techniques results in higher productivity per person, giving rise to higher incomes higher savings, and higher investments per capita This makes possible the generation and application of improved techniques, which result in higher productivity per person and so the process continues (Girvan 1983, 11) Technical cooperation resources are provided in the form of specialized personnel training, machinery and equipment and finance This is a unique instrument of technology transfer in North-South" economic relations It is unique in the sense that technology is transferred almost invariably in non-commercial transactions [2] This is what Dichter et al (1988) aptly called development-oriented technology transfer

The most fundamental aspect of any development cooperation program is the transfer of knowledge and skills to the local participants in the program The argument is that in the future the latter will be sufficiently equipped to implement similar or even more complex activities by themselves without recourse to foreign support To be sure, the ultimate goal is to empower the recipient institutions and people to take charge of their own lives In essence, they should participate in designing and implementing development projects and programs in order to encourage technological initiative at grassroots level This is commonly referred to in the literature as 'building national technological capabilities" (Cooper 1974) The two traditional methods of transferring knowledge and skills are formal training through schools and colleges and counterpart training, that is, working together with an expatriate on the same tasks for a given period of time

To create forms of knowledge transfer adapted to specific work situations while avoiding interpersonal difficulties associated with counterpart training, institution twinning has recently emerged The theory behind institution twinning is that an established institution possesses what has been commonly called corporate skills—experiences accumulated from working in a particular field for a long time This includes methods and approaches for tackling new situations that are specific to that institution and that are acquired through time by some employees of that institution (Cooper 1984, Mothander and Flodman 1989)

The simplest form of institution twinning is set up between two institutions that are in the same or in a very similar field of operation One of the partners (senior) informs the other (junior) how it would solve possible practical problems, and it shares work methods, research techniques, and

[2] The commercial forms of technology transfer include among others technical assistance agreements know how agreements joint ventures sub contracting and licensing and franchising An informed discussion on this subject is found in Vaitsos (1975)

findings as well as working manuals It would arguably be up to the junior partner to adapt the acquired knowledge to the local working conditions and circumstances

At the institutional level effective knowledge and skill acquisition and accumulation is a complex process It takes a critical mass of accumulated knowledge to rationally determine what additional skills knowledge and technologies are required how to search and select the types and knowledge needed how to negotiate for favorable terms of transfer how to adapt and absorb new production systems and finally how to generate and diffuse technologies in selected areas (Stewart 1978 Bell 1984) The following case studies demonstrate how different modes of technical cooperation delivery and institutional environment in Tanzania have impacted skill and knowledge acquisition as well as technology transfer

The Mbegani Fisheries Center An Ill-conceived Project

For a long time the government of Tanzania failed to evolve a comprehensive aid policy and attendant aid instruments to guide development activities in this important issue area Ideally, such a policy would have defined the role of foreign aid and specified aid management institutions In turn, the aid management institutions would have provided plans that identified lists of projects and programs, their sequencing order and local contributions as well as the amounts of foreign resources being requested

In theory the overall responsibility for aid management in Tanzania is shared by the Ministry of Finance and the Planning Commission Sectoral and operating ministries and parastatals are required to channel their proposals for aid assistance through the Planning Commission where they are scrutinized in relation to the national and sectoral economic priorities From there the proposals are passed on to the Ministry of Finance which is responsible for contacts with foreign governments and aid agencies to ensure that proposals match the available resources That done plans and budgets are submitted to the Cabinet and later to the Parliament for discussion amendment, and approval

However, in the absence of countervailing national power in terms of sufficient policy clarity and adequate administrative oversight donors tended to exert growing influence over the choice design, and implementation of aid-assisted projects

Because of such institutional weaknesses many technical cooperation projects in the country were donor-conceived -designed implemented, and indeed -driven This led, more often than not, to projects that were either inappropriately packaged, poorly targeted or lavish for the actual need As a consequence, the overall impact of technical cooperation projects and programs on the intended populations in Tanzania has been considered insignificant (Green 1973 Freeman 1982, Nordic Report 1988) The Mbegani Fisheries Development Center project supported by the Norwegian aid is one of the classic examples

The Bagamoyo-based Mbegani Fisheries Development Center was established in 1966 by the government of Tanzania along with two colleges to train fisheries personnel In 1972 the government approached Norway to request assistance in developing the fisheries sector The government of Norway accepted the request and the Norwegian Agency for International Development (Norad) embarked on assessing such support

Norad sub-contracted a Norwegian fisheries development corporation—Fideco—to undertake feasibility studies of the fisheries sector in Tanzania and then advise on the kinds of support projects and programs to be provided After a sketchy and impressionistic survey the consultants recommended that Norad rehabilitate, expand, and modernize the center facilities for purposes of industrial fisheries training and development To establish a modern industrial fisheries training college Fideco further recommended that the center be provided with two mechanized training vessels a fishing receiving station a mechanical workshop and a jetty and that the existing infrastructure be refurbished and upgraded Apparently Norad and later the government of Tanzania accepted almost all the recommendations Additionally Fideco consultants were awarded a new contract to execute the entire project Eleven experts were attached to the project to design and conduct courses leading to 2 year certificates and 3-year diplomas as well as supervising the construction works

It is important to underscore that after signing a letter of understanding, the government of Tanzania seemed to have left almost all the project preparations and execution in the hands of Fideco consultants and, remotely, Norad The center's faculty and staff were not adequately involved As a result, the Fideco was relatively free to determine the nature and level of education to be provided, the curriculum content, and the fishing vessels and gear to be procured and used for training Had the government of Tanzania or its designated agencies involved themselves at all stages of the project cycle, subsequent costly policy decisions would have probably been avoided if not minimized Joint and comprehensive feasibility studies, for example, would have presumably facilitated informed decisions regarding training and development programs at the center Left to operate relatively independently, Fideco not only missed the intended beneficiary but also went out of its way to over-design the project to the consternation of both Norad and the government of Tanzania [3]

Studies by Mytelka (1981) of the textile industry in Ivory Coast and by Parker (1979)of the Tanzania National Development Corporation found that poorly supervised private consulting firms tend to over-design and over-build facilities because the fees charged are usually proportional to the value of the equipment and machinery installed Mytelka and Packer's observations were confirmed in my study of the Tanzanian textile industry (Rugumamu 1989)

> with little or no effective state participation in the machinery procurement and installation foreign private companies have a strong propensity to overbuild plants and substantially increase the costs from which their fees are calculated Foreign consulting companies and construction firms did just that in the foreign aided modernization exercise in the Tanzanian textile industry

Fideco might have been influenced by the same profit motive After all, it was a conglomerate of firms in the fisheries and boat-building business in Norway In the absence of international bidding procedures, a practice common in bilateral aid, there are opportunities for overinvoicing In fact, over 63% of the technical cooperation funds provided went into the procurement of the machinery and equipment as well as paying the building contractors fees (table 3)

Table 3 Distribution of Norad grants to Mbegani Fisheries Center, 1974-83

	Amounts (NKr millions)	%
Feasibility studies	199	132
Building contracts	800	533
Planning and designing	99	66
Education planning	37	24
Project administration	89	59
Machines and equipment	141	94
Operational costs	134	89
Total	1499	1000

Source Mbegani Fisheries Development Center accounts (1984)

The types of training vessels and their gear as well as the instructors background significantly influenced the nature of training and the skills imparted at the center The training was dominated by higher-level fisheries training (diplomas and certificates), which was intended for large-scale industrial fishing The MV Mafunzo and other mechanized vessels—the main training vessels—use only large-scale industrial fishing gear High sea trawling, purse seining, and trolling are the major fishing techniques imparted at the center A study of the center's recent graduates and their employers confirmed that the knowledge and skills imparted at the center were, more often than not, far removed from the fishing conditions in Tanzania vessels (Eastern and Southern African Universities Research Program 1988b, 110-12) The graduates were usually faced with lack of modern working tools, equipment, facilities, and standard fishing Some of the graduates who work among artisanal fishing communities as extension officers were quickly disillusioned as they discovered that their professional knowledge of large-scale industrial fishing could not be easily adapted to those completely different circumstances

Artisanal fishing has been estimated to contribute 95% of the annual fish harvest in Tanzania This traditional fishing industry employs about 60,000 people on a full-time basis and about 3,000 people are engaged in part-time fishing and other fisheries-related activities (Eastern and Southern

[3] The center has since 1982 been operating at a capacity of only 112 students for both certificate and diploma programs The cost per student per year is more than four times higher than comparable institutes elsewhere in the country

African Universities Research Program 1988a)[4] The main fishing vessels are dhows and canoes largely propelled by sail The common fishing gear employed includes gill-nets, shark-nets, seine-nets cast-nets traps and hard lines Motorized gear is uncommon among traditional fishing communities The Fideco feasibility study reports and recommendations failed to capture the importance of this fishing community in the industry (Havnevik et al 1988, 218-30) Had detailed studies about the nature scope, and problems of the artisanal fishermen been undertaken, they would have gone a long way in identifying appropriate technologies to import what research and development activities to undertake and how best to involve the target fishing communities

Not surprisingly, the reports of the Nore Commission (1979) and the Royal Norwegian Ministry of Development Cooperation (1986) on the center s performance strongly criticized the objectives of this technical cooperation project Both reports deplored undue emphasis on the higher-level high technology demanding training programs Both reports were also critical of the shoddy development activities that the center had been undertaking Consequently various costly recommendations were later made to restructure the center s training and development programs so as to give special attention to the needs and concerns of artisanal fishermen (Royal Norwegian Ministry of Development Cooperation 1986 43-52) Fideco was later fired Two other Norwegian construction companies were quickly hired to complete the infrastructural works at the center and undertake training

After this initial embarrassing performance Norad sought to maximize the Norwegianization of the project management (Gran 1991) to ensure timely completion of the project In retrospect this donor strategy was important in two ways To the aid agency bureaucrats doing the technically defined jobs as quickly and as efficiently as possible was important for their ultimate occupational advancement To the donor government it was important that they showed their Parliamentarians how many projects were successfully completed in a particular fiscal year From that point onwards, the issue of technology transfer and institution capacity building took a back seat This tendency, rather common among donors, is what Brenner (1984 3) cogently refers to as a drive toward quick visibility results,' regardless of the impact on the recipients

Table 4 Mbegani Fisheries Development Center budget 1985/86-1990/91 (T Sh millions)

Year	Recurrent (Tanzania)	Development (Norad)	Total
1985/86	4 2	6 6	10 8
1986/87	5 6	16 6	22 2
1987/88	10 0	17 2	27 2
1988/89	17 9	36 3	54 2
1989/90	25 5	46 3	71 8
1990/91	36 7	98 9	135 5

Source Mbegani Fisheries Development Center accounts (various years)

Estimate

It has to be emphasized that subsequent problems at the center were a product of the initially poorly conceived project Even after several evaluation mission reports indicating poor planning design, and performance, Norad was reluctant to abandon the project (this option was considered undiplomatic) To save face, it hastily invested in this otherwise unviable project by adding yet new programs (Havnevik et al 1988) Between 1986/87 and 1990/91, Norad and the government of Tanzania invested over T Sh 100 million shillings (table 4) to establish a 1-year certificate course for extension officers, opened additional short course training posts for small-scale fishermen and invigorated the center s development activities Those huge amounts would otherwise have been spared for other pressing development activities had the donor and the recipient government carefully appraised the problem at the outset what to solve, how to solve it and with what specific resources

The government of Tanzania deserves a full share of blame Its inherent appetite for big projects neatly coincided with the donor s desire for high technology sales and aid-tying One would have expected the government to assume a lead role in all key issues of the technical cooperation delivery process and to identify critical areas of technical cooperation intervention However the obsession

[4] The activities include among others marketing distribution net making marine engine repair boat building and the production of other fishing accessories For fuller details see Eastern and Southern African Universities Research Program (1988a)

for conspicuous projects far outweighed the underlying economics

Uyole Agricultural Center A Targeted Beneficiary

In 1968 the government of Tanzania requested technical assistance from the Nordic governments to establish an integrated agricultural institute, Uyole Agricultural Center for the development of four southwestern highland regions of Tanzania After two feasibility study missions—the Nordic Agricultural Experts and the Nordic Appraisal and Planning Experts missions—a technical cooperation agreement was signed in 1972 The Finnish government was given the responsibility for executing the project on behalf of other donors Among other things, the agreement provided

- a grant for investment in various facilities and equipment
- consultancy services for construction and design of buildings
- personnel assistance program for 145 man-years during a 5-year period
- scholarships for 37 Tanzanians for university-level education
- the financing of Nordic administration costs

In 1975 Iceland became a supporting member of this project The agreement was renewed three times up to 1985 when all but Finland withdrew from the project From 1985 to 1992, the Finnish government alone supported the Uyole project

By 1975 most of the research and training offices had been completed as were the laboratories, greenhouses, workshops, and livestock facilities The training program became operational 2 years later Until the late 1970s, both the research and training programs understandably were dominated by Nordic experts This picture began to change in the early 1980s as Tanzanians returned to the center with graduate degrees

The Act of the Parliament that established the center mandated production-oriented research and training activities to solve immediate technical problems of farmers To this effect, the crop research programs include maize rice, Phaseolus beans potatoes, wheat fruits, and vegetables In turn research on each crop covers breeding agronomy, crop production and on-farm studies The livestock programs concentrate on pasture development and pasture nutritive value studies for dairy cattle In brief, the target group of this technical cooperation project was unambiguously stated and correctly understood from the start

The Uyole Agricultural Center is the only research institute in Tanzania with a full-fledged extension section and extension specialists It organizes regular researchers demonstrations and on-farm trials along with its village district and regional agricultural extension networks The center publishes extension leaflets booklets as well as the *Uyole Research Bulletin* Assessing the overall performance of the center a World Bank evaluation team (World Bank 1988 8) remarked

> The Uyole Agricultural Center has been more successful than others in reaching farmers helped by its extension section it can be regarded as a useful model for regional adaptive research which could be replicated The experiment of combining training and research has also worked well

On the training side the center has a planned capacity of 500 students It houses five academic departments and conducts three different programs diplomas, certificates and short courses for farmers By 1991, the center had trained 6 600 Tanzanians of which nearly 3 000 received diplomas or certificates and 3,700 attended short courses for farmers (table 5)

Moreover, despite occasional loss of staff from the center to other more attractive local and international jobs, the Uyole technical cooperation project has managed to train and retain a handsome pool of its professionals (table 6) A variety of imaginative incentive schemes have been created to motivate and retain researchers and trainers These include, among others subsidized rent free medical care, free transport, research funds and equipment and subsidized rental charges for agricultural

Table 5 Uyole Agricultural Center graduates 1977-91

Awards	1977 1979	1980-1989	1990-1991	Total
Diplomas	281	1 580	240	2 101
Certificates	262	383	142	787
Short courses	163	2 264	1 295	3 722
Total	706	4 227	1 677	6 610

Source Uyole Agricultural Center files

equipment for private use In September 1991 for instance the center employed 83 agricultural professionals and 138 technicians In effect we can conclude that knowledge and skills have been effectively transferred to the nationals through this Nordic technical cooperation arrangement The program has built and strengthened national research and training capabilities The national experts have accumulated sufficient capabilities to identify agricultural problems define appropriate research projects and deliver scientific solution to their client As we shall later demonstrate the center s impact on the agricultural development in the regions concerned has effectively been felt

The Southern Highlands Maize Improvement Program graphically demonstrates the Uyole research success It has been based at the center since 1971 The long term objectives of this program include forming agro-economic packages for maize for different agro-ecological zones and farming systems found in the region breeding hybrids and open pollinated varieties and monitoring pests and diseases of maize

In the last 20 years or so the maize research program has successfully provided the requisite information on land preparation varieties planting time rates and methods of fertilizer application the use of organic manures rotations plant density and arrangement and weed and pest control This information has been passed on directly to the farmers or indirectly through the extension system Similar successes have been recorded in the research and development of sorghum millet rice wheat and grain legumes (Moshi and Marandu 1988, Marandu 1988)

The Uyole achievements would hardly have been possible without strong donor support Its up-to date infrastructure for research and extension services and staff retention schemes for example have been uninterruptedly maintained by technical cooperation resources The logical questions that follow are how long can such a support last? Is it sustainable after donor withdrawal? Or is this yet another white elephant?

Despite the accomplishments the technical cooperation management for the Uyole center has not always been rosy The perennial question of sustainability stands out During the initial construction phase (1971 76) for example the Nordic governments extended T Sh 256 million to the project while the Tanzanian government contributed T Sh 240 million or 58% and 42% respectively One would have expected that the local financial contributions would have gradually risen Surprisingly, subsequent agreements between the Tanzanian and the Nordic governments neither paid sufficient attention to the exact size of the local contributions over time nor to the Nordic timetable for phasing out The 1980 *Joint Nordic Tanzania Evaluation Mission Report* (Uyole Center 1980) for instance, casually noted the serious drop in the quality of research and training at the center as a large number of Nordic experts concluded their contracts without commensurate replacement Accordingly, the report recommended no further expansion of the programs and a substantial rise in the government Once again, no exact estimates were proposed nor deadlines suggested This disturbing omission is likely to negatively impact the center s programs when the Finns finally withdraw

It is worth pointing out that Tanzania s reckless investment drive of the 1960s and 1970s had given little attention to future resource implications of those investments When the economic crises set in the mid 1970s the previously aid-funded projects came to a standstill as the operating resources dried up In turn this led to chronic underutilization of capacity in industry failing social services low productivity and the like Between 1985/86 and 1989/90 the Tanzanian government subvention to the center averaged only 43% (table 7) It would appear on the surface that no conscious effort was made to gradually increase the government s relative annual contributions to the center for an eventual smooth takeover The government belatedly realized in the 1980s that it was difficult to sustain even important services like agricultural research and education A further breakdown of the 1988/89 and 1989/90 figures of Uyole (table 8), for instance demonstrates that Finnida has all along been supporting the core activities in the research

Table 6 Uyole staff positions (September 1991)

Section	Professionals	Technicians	Total
Research institute	48	81	129
Training institute	25	35	6
Service department	10	22	32
Total	83	138	221

Source Uyole Agricultural Center files

Table 7 Finnish and Tanzanian governments contributions to the Uyole Center, 1985/86 to 1989/90

Year	Contribution (T Sh millions)			Tanzanian contribution (%)
	Finnish	Tanzanian	Total	
1985/86	25	29	54	54
1986/87	98	52	160	39
1987/88	108	72	180	40
1988/89	158	138	296	47
1989/90	279	151	430	35

Source Uyole Agricultural Center accounts (various years)

and training divisions at Uyole Given the pressing economic conditions of the 1990s, it is unlikely that the government of Tanzania will fill Finnida s gap in the short and the medium runs This is a sign of poor economic planning and management

Institution Twinning and Transfer of Technology

Despite the absence of a national policy framework on technical cooperation the Sokoine University of Agriculture s new faculties, forestry and veterinary medicine, have effectively managed to acquire and assimilate technology through technical cooperation arrangements The secret behind this success is the university's relatively strong institutional and organizational capacity which was a significant bottleneck in Mbegani and Uyole Indeed, the OECD observed, sustained and self-reliant development depends on the strength and quality of the country s institutions (Development Assistance Committee 1989 107) To be sure, such incidence confirm our initial assumptions about the institutional capacity of the recipient institutions Under certain circumstances, the very conditions of power asymmetry between donor and recipient, dialectically create bargaining spaces' that the weak can exploit to advance its own interests

The University of Sokoine skillfully deployed its accumulated knowledge and experience to strike favorable deals with donor agencies This performance confirms Muscat's conclusions (1986, 61) that the major determinant of technical cooperation effectiveness is the level of development of the recipient institution, that is, the degree to which the institution in question is able to absorb and exploit the technical and material resources provided from outside Indeed, the observation that technology transfer and technical cooperation effectiveness increase through time, along with rising skills and institutional capacities, implies that effectiveness would normally be low among the least developed countries and institutions

The Faculty of Forestry was established in 1973 by the government of Tanzania, with Norad providing a generous grant for equipment, infrastructure laboratories, vehicles, and foreign academic staff From 1973 to 1991, Norad spent over US$30 million on the project The University of Sokoine had on its part, undertaken a thorough internal needs assessment long before the initial feasibility studies were carried out In the project agreement documents, the fine details of the project activities were unambiguous, and priorities were well articulated and carefully sequenced Moreover, the effectiveness of the recipient's participation in the project planning, design, and implementation is obvious from the ways in which technology transfer mechanisms were programmed and implemented

A comprehensive training program for young Tanzanian academicians and technicians was drawn up specifying colleges, areas of specialization, and time frames The project further identified

Table 8 Distribution of Tanzania government and Finnida expenditures for Uyole Agricultural Center, 1989 and 1990

Items	1989 (T Sh millions)			Tanzania expenditures (%)	1990 (T Sh millions)			Tanzania expenditures (%)
	Government	Finnida	Total		Government	Finnida	Total	
Research institute	36 0	56 0	92 0	39	34 5	100 0	134 6	26
Training institute	26 2	23 2	49 4	53	31 0	33 9	64 9	48
Others (collaboration & training)		17 7	17 7	0		17 4	17 4	0
Rehabilitation		26 8	26 8	0		54 6	54 6	0
Institutional support	72 1	34 4	106 6	68	76 9	73 2	150 0	51
Development	9 0		9 0	100	3 6		3 6	100
Total	138 0	158 2	296 3	47	151 5	279 4	43 9	35

Source Finnida/Uyole Annual Meeting Uyole 11 12 November 1991

the School of Forestry at the Agricultural University of Norway as a senior counterpart in a twinning arrangement with the Sokoine University of Agriculture The senior counterpart was charged with several responsibilities such as training Tanzanian counterparts to raise scientific and technological skills impart methodologies improve organization of research stations and laboratories and develop collaborative research and training By contrast the Mbegani Fisheries Development Center project agreement did not involve any form of institutional cooperation

Together with an initial skeleton of national experts the project had by mid 1991 awarded over 300 B Sc degrees plus 57 M Sc degrees and 14 Ph D degrees About 70% of these were Tanzanians The rest came from Kenya Uganda Rwanda Malawi Ethiopia Sudan Nigeria Ghana and Gambia (Faculty of Forestry 1990)

In less than two decades the Faculty of Forestry has grown from modest beginnings to a fully-fledged faculty In 1974 for instance there were 12 Norwegians experts at the faculty By 1992 only one expatriate remained The phasing out of expatriates and the training of the nationals were implemented in a timely fashion Moreover the faculty has already been earmarked as a center of excellence in the southern African region It is in fact currently running graduate programs for the whole region Above all as a clear testimony of maturity the Faculty of Forestry has recently published a comprehensive research priorities booklet that outlines its areas of research interests and strengths (Faculty of Forestry 1991)

Going by its annual research publications and consultancy reports the Faculty of Forestry at the Sokoine University of Agriculture has produced outstanding contributions in local and international journals The main areas of research fall under two broad categories applied and adaptive research and strategic and basic research (Faculty of Forestry 1991 This is yet another testimony that scientific knowledge and skills have been effectively transferred to the local researchers

It is also interesting to observe that the government of Tanzania usually allocates insignificant amounts of money to university research and development A 1987 study of 14 universities in the region estimated that on the average they receive about 2% from their recurrent expenditure for research activities (Eastern and Southern African Universities Research Program 1987 198-9) As a result most of the research funds have been obtained through competitive research applications and through collaborative research programs with foreign universities and research institutions The ability to compete and win in regional and international research contests is more evidence that the Faculty of Forestry at the Sokoine University has accumulated substantial research capabilities

The government of Tanzania has also come to recognize the importance of forestry scholars in influencing public policy and management Not infrequently some senior faculty members have been called upon to provide expert policy advice to the government as well as sitting on important boards of directors Above all the concept of think tanks is gradually gaining currency in the country In particular the Ministry of Agriculture and Livestock Development is slowly mobilizing the research resources of faculties of agriculture veterinary sciences and forestry for policy management

The successes that were recorded in the Faculty of Forestry were more or less replicated in the Faculty of Veterinary Medicine at the same university The latter was established with a generous grant package from the government of Denmark through the Danish International Development Agency (Danida) The specific objective of Danida was to support Sokoine University of Agriculture in building up a fully-fledged faculty of veterinary science capable of conducting research and providing training at degree levels ' During phase 1 of the project (1979 86) Danida extended a comprehensive package of about US$35 million to the university for infrastructure including office buildings, laboratories and equipment as well as covering the recurrent costs for graduate training of Tanzanians abroad research and teaching expenses for Danish academicians working at the faculty and funds for regular maintenance and supplies

During phase 2 (1986-91) Danida provided about US$4 million to pay for graduate scholarships of Tanzanian academicians maintenance of buildings and equipment as well as paying recurrent expenditures on research and teaching materials The technical cooperation package for the Veterinary Science included a twinning arrangement

Table 9 Recurrent budget for Faculty of Veterinary Science, 1985/86-1990/91

	Recurrent budget (T Sh millions)			
Year	Danida	Tanzania	Total	Tanzania (%)
1985/86	12 4	3 9	16 3	24
1986/87	23 5	4 6	28 1	16
1987/88	23 5	7 7	31 2	25
1988/89	23 5	11 9	35 4	34
1989/90	23 5	29 0	52 5	55
1990/91	12 3	53 0	65 3	81

Source Faculty of Veterinary Science (1991 12)

with the Royal Veterinary and Agricultural University in Copenhagen The latter provided the Sokoine University with short- and long-term professors, organized joint Ph D programs for Tanzanians, and supported collaborative research Moreover national veterinary academicians and their Danish counterparts designed and implemented degree curricula that suited the tropical veterinary conditions By the end of the1990/91 academic year, over 100 B V S degrees, plus 5 Ph D degrees and 12 M V M degrees had been awarded It is envisaged that by 1993 the project will have trained 33 Ph D s The 1991 faculty review mission (Faculty of Veterinary Science 1991, 8) had the following to say about this project

> The overall impression is that the Faculty of Veterinary Medicine is now fully operational as far as the undergraduate program is concerned the faculty is well organized runs and provides facilities for training and research on an international level

Our interviews revealed that initially all graduate training programs were tied to Denmark This arrangement remained so regardless of whether the Danish institutions were adequately prepared to train veterinary science experts for tropical conditions or not However, this arrangement was later changed to allow Tanzanians to join institutions of their own choice Clearly, this clause in the contract demonstrates weak bargaining capabilities on the part of the recipient institution We are arguing that untied training assistance should have been negotiated to allow Tanzanians to train at any reputable institutions outside Denmark with a track record of tropical veterinary research and training

Several possible explanations can be advanced in this regard It is quite possible that the local negotiators were too cautious to embarrass their government In other words, they perceived a possibility of losing the entire offer if they were hard-nosed aid negotiators It is also possible that the recipient negotiator possessed insufficient knowledge about alternative training arrangements and the costs involved This aspect would surely call for detailed research of its own Explaining the importance of information in bargaining, Singer (1975, 379) perceptively noted that (emphasis in original)

> Information like technology feeds upon itself If you do not have enough information to begin with to know where to look for the information that you need, or to know what new information could be assembled your initial inferiority is bound to be sharpened and perpetuated This unequal bargaining situation will affect *all* relations between the investing and the borrowing countries whether labeled aid trade investment transfer of technology technical assistance or any other

An additional explanation stems from mistaken notions that technical cooperation experts and advisors know what is good or bad for recipient institutions and beneficiary populations This dependency mentality is normally ingrained in asymmetrical relationships of this kind Too much bargaining would be perceived as poking one s nose in the donors' business That bargaining stance, so the argument goes, might result in losing the whole deal altogether In short, these explanations account in one way or another, for the repeated occurrence of unfavorable restrictive clauses in technical cooperation packages in Tanzania and elsewhere in the Third World

However, for its part, the government of Tanzania agreed to a systematic phasing-out arrangement for the recurrent budget of the Faculty of Veterinary Medicine The government committed itself to establish a procedure for this exercise since the 1988/89 financial year through a letter of understanding between the project coordinator and the Treasury It was agreed that by the end of 1993, the Danish contribution to operational costs would cease This means that the local contribution would increase correspondingly Table 9 shows there has been a conscious effort by the government to raise its annual contributions to this faculty's recurrent costs to reasonable levels The figures have increased from 24% of the total recurrent budget in 1985/86 to about 81% in 1990/91 In addition, the Danish government agreed to set aside about US$1 million annually for the next 5 years as a foreign

exchange facility to enable the faculty to procure foreign supplies and parts for the installed machinery and equipment Our skepticism is however about what will happen when this facility is also phased out Will the government assume the responsibility fully? Based on past experience sustainability is the Achilles heel for most technical cooperation projects in Tanzania

All in all this was one of few technical cooperation projects that was professionally designed and implemented in Tanzania This second time around, the Sokoine University carefully undertook a needs assessment well in advance The faculty was fully involved in project planning design and implementation The 1990 Danida Review Report (Danida 1990 8) said

> It is the impression of the Review Mission that most of the project objectives were carried out very well This is mainly due to an obviously out-standing co operation and coordination between the Tanzanians and the Danish advisors as well as highly enthusiastic work from everybody

This evidence contradicts Gran s findings about institution twinning arrangements in Tanzania (Gran 1991) As earlier argued increased institutional capacity for research and training through the twinning arrangement presupposes, among other things a congruency of objectives between the donor and the recipient a thorough internal needs assessment absorptive capacity and above all the right technical cooperation inputs both in quantity and quality The Norad academic improvement project at the Institute of Development Management lacked adequate preparation and design According to Gran (1991 62), Norad had sloppily operationalized its policy objectives for enhancing the teaching and research capacities at the institute The latter s technical and institutional capacity in shaping the same were considered doubtful also Also Norad deployed poor quality advisors who in turn reinforced the poor quality of the project To crown it all, the senior twinning institution—Agder College of Kristiansand—did not measure up to the envisaged tasks of collaborative research and teaching As result that arrangement had insignificant positive impact on institutional capacity building

Conclusion

Four conclusions are in order First the nature and capability of the recipient institution largely influences the amount of gains to be reaped risks to be faced and the damage to be suffered from such international transactions As earlier postulated in the theory institutional capacities will be reflected in its in house ability to undertake comprehensive and realistic technical cooperation needs assessment and planning When carefully enforced this mature policy stance would minimize chances of donors imposing low priority technical cooperation projects or inappropriate technology packages on a recipient country Moreover, institutional capacity would also be reflected in the level of participation of the recipient in technical cooperation project planning design and implementation It was argued that effective knowledge and skill transfer presupposes *ab initio* the recipient s full participation in all project cycle activities Relatedly, the capacity of the recipient institution would be reflected in its ability to direct, regulate, and monitor the activities of the technical cooperation executing agencies in order to ensure that only the stated project objectives were pursued

Second it was found that whereas the overall distribution of capabilities shapes the bargaining outcome in international transactions in favor of the strong, those same situations also dialectically create bargaining spaces that the weak can exploit in their favor As the two case studies at the Sokoine University of Agriculture demonstrate appropriate bargaining strategies and tactics can be skillfully exploited to allow the weak to prevail over the strong under conditions of power asymmetry

The third conclusion is closely tied to the second one Technical assistance strategies of the recipient institutions assume the existence of a comprehensive national technical cooperation policy framework within which to operate In our opinion such a framework should be sufficiently detailed to deter its abuse in practice Moreover, it should provide broad guidelines to help technical cooperation planners, negotiators and monitoring agencies in their day-to-day activities The failure to institute such a framework in Tanzania jeopardized the chances for technical cooperation effectiveness As other researchers have extensively documented, unplanned

low priority technical cooperation were usually approved, and some projects were poorly designed and unprofessionally implemented while government counterpart funding was rarely forthcoming In short, most technical cooperation projects in Tanzania lacked the institutional basis for sustainability (Mongula 1990, Nordic Report 1988)

Finally, there is urgent need to sensitize the state bureaucracy in the Third World to the hidden agendas of international development agencies To be sure, political leaders in donor countries make decisions concerning the broad political and economic interests that the technical cooperation resources have ultimately to serve These include, among others, economic interests, promotion of foreign policy, international security concerns, and humane internationalism (Stokke 1989, 9-15, Rugumamu 1991 65-66) In the absence of a realistic national policy framework and effective recipient participation, such interests are bound to determine technical cooperation project design and implementation The motives behind aid policies are often intertwined and therefore very difficult to disentangle by the recipient countries Public utterances notwithstanding, rarely are aid policies simply altruistic Nor need development objectives of donor and recipient countries always coincide It is therefore imperative that recipient countries be clear about their critical technical cooperation needs and strive not to lose focus on their priorities during negotiations As earlier argued, such a laudable posture is likely to greatly minimize the recipient country s economic and political vulnerabilities

Literature Cited

Ake C 1979 *Revolutionary pressures in Africa* London Zed Press

Bagachwa M S D and S Rugumamu 1991 Effectiveness of technical assistance in Tanzania with reference to manpower policies Dar es Salaam UNDP

Baskin V 1985 *Western aid Myth and reality* Moscow Progress Publishers

Bell M 1984 Learning and accumulation of industrial technological capacity in developing countries In *Technology capability in the Third World* ed M Fransman and K King 187-209 London Macmillan Press

Bernis M 1990 *A micro economic approach to technical cooperation in Africa* New York UNDP

Bhatt V 1980 *Reality and rhetoric Studies in Economic development* London Weidenfeld and Nicolson

Brenner, J 1984 Building institutional capacity for policy analysis An alternative approach to sustainability *Public Administration and Development* 4 1 13

Cassen R 1986 *Does aid work?* Oxford Clarendon Press

Cooper C 1974 Science policy and technological change in underdeveloped economics *World Economy* 2(2) 16-31

Cooper, L 1984 *The twinning of institutions Its use as a technical assistance delivery system* World Bank Tech Paper 23 Washington D C World Bank

Danida 1990 *Review report* Copenhagen

Development Assistance Committee 1989 *Development cooperation in the 1990s* Paris OECD

Dichter D et al 1988 *A guide to technology transfer for small and medium sized enterprises* Aldershot Hants UK Gower Publishing House

Doornbos M 1990 The African state in academic debate retrospect and prospect *Journal of Modern African Studies* 28(2) 179 98

Eastern and Southern African Universities Research Program 1987 *University capacity in eastern and southern African countries* London James Currey

Eastern and Southern African Universities Research Program 1988a *The effectiveness of Mbegani Fisheries Development Center training programs* Dar es Salaam

Eastern and Southern African Universities Research Program 1988b A *report of the tracer study on the Mbegani Center trainees* Dar es Salaam

Faculty of Forestry 1990 *Review mission report* Morogoro Tanzania Sokoine University of Agriculture

Faculty of Forestry 1991 *Research priority areas in the Faculty of Forestry* Morogoro Tanzania Sokoine University of Agriculture

Faculty of Veterinary Science 1991 *Review mission report* Morogoro Tanzania Sokoine University of Agriculture

Freeman L 1982 CIDA wheat and rural development in Tanzania *Canadian Journal of Development Studies* 16(3) 479-504

Girvan N 1983 *Policies for small developing economies A study of the Caribbean* Mona Jamaica University of the West Indies

Gran T 1991 *Norad s contribution to entrepreneurship mobilization in Tanzania* Bergen Norway University of Bergen

Green H 1973 Technical assistance and the Tanzanian administration In *Technical assistance ad ministration in East Africa* ed Y Tandon Stockholm Almquist and Wiksell

Havnevik, K et al 1988 *Tanzania Country study and Norwegian aid review* Bergen Norway University of Bergen

Hayter T 1970 *Aid as imperialism* London Penguin Books

Jalee P 1968 *Pillage of the Third World* New York Monthly Review Press

Kleemeier L 1982 Tanzania's policy toward foreign assistance in rural development *Taamuli* 12 62-85

Lipton M and J Toye 1990 *Does aid work in India?* New York Routledge

Mwandu W 1988 The Southern Highlands Maize Improvement Program In *Proceedings of the National Workshop on National Agricultural and Livestock Development in Tanzania* 124-33 Dar es Salaam Ministry of Agriculture and Livestock

Mongula B 1991 *Technical cooperation projects in Tanzania* Dar es Salaam UNDP

Morss R 1984 Institutional destruction from donor and project proliferation in sub-Saharan African countries *World Development* 12(4) 465 70

Moshi A and W Mwandu 1988 Maize research in Tanzania In Proceeding of the National Workshop on National Agriculture and Livestock Development ed F Shao et al 110 123 Dar es Salaam Ministry of Agriculture and Livestock

Mothander B and K Flodman 1989 *Experience of institutional cooperation in public administration sector in Tanzania* Dar es Salaam Ministry of Finance Economic Affairs and Planning

Muscat R 1986 Aid effectiveness Technical cooperation *IDS SUSSEX Bulletin* 17(2) 58 65

Mushi S and H Kjekshus eds 1982 *Aid and development Some Tanzanian experience* Uppsalla Sweden Uppsalla Institute for International Studies

Mutharika G 1989 Foreign assistance and local capacity building *The European Journal of Development Research* 1(1) 108 23

Mytelka L 1981 Direct foreign investment and technology choice in the Ivorian textiles and wood industries *Vierteljahresberichte* 83 60 81

Nkonoki S R 1991 Development strides foreign aid and transfer of technology with special reference to Tanzania Piper presented to the African Norwegian Seminar Bergen Norway University of Bergen

Nordic Report 1988 *Evaluation of the effectiveness of technical assistance personnel A report to Danida Finnida Norad and SIDA* Copenhagen Danida

Nore Commission 1979 *Mbegani Fisheries Development Center* Oslo Royal Norwegian Ministry of Development Cooperation

OECD 1982 *Geographical distribution of financial flows to developing countries* Paris

OECD 1984 *Geographical distribution of financial flows to developing countries* Paris

OECD 1986 *Geographical distribution of financial flows to developing countries* Paris

Parker I 1979 Contradictions in the transition to socialism The case of the NDC In *Toward socialism in Tanzania* ed B Mwansasu and C Pratt 46 71 Toronto University of Toronto Press

Payer C 1982 *The World Bank A critical analysis* New York Monthly Review Press

Poulantzas N 1974 Internationalization of capitalist relations and the nation state *Economy and Society* 3(2) 145-79

Royal Norwegian Ministry of Development Cooperation 1986 *Mbegani Fisheries Development Center Evaluation Report* Oslo

Rugumamu S 1989 Internationalization of capital The textile industry in Tanzania *Review of Radical Political Economics* 21(4) 54 72

Rugumamu S 1991 National security dilemma in Africa Setting the record straight *Tanzanian Journal of Development Studies* 1(1) 64-77

Rugumamu S 1992 Technical cooperation administration in Tanzania Unresolved policy issues *The African Review* 19(1&2) 78 97

Rugumamu S 1993 Foreign assistance dependence in Tanzania A case of a besieged state In *Economic policy under a multiparty system in Tanzania* ed M S D Bagachwa 173 92 Dar es Salaam Dar es Salaam University Press

Singer H 1975 The distribution of gains from trade and investment revisited *Journal of Development Studies* 2 362 80

Stewart F 1978 *Technology and development* New York MacMillan

Stokke O 1989 The determinants of Norwegian Aid policy In *Western middle powers and global poverty* ed O Stokke 159 230 Uppsalla Sweden Scandinavian Institute of African Studies

UNDP 1987 *Development cooperation report Tanzania* Dar es Salaam

UNDP 1988 *Development cooperation report Tanzania* Dar es Salaam

UNDP 1989 *Development cooperation report Tanzania* Dar es Salaam

UNDP 1990 *Development cooperation report Tanzania* Dar es Salaam

Uyole Center 1980 *Joint Nordic Tanzania mission reports of Uyole* Helsinki Finnida

Vaitsos C 1975 The process of commercialization of technology in the Andean Pact In *International firms and modern imperialism* ed H Radice London Penguin Press

Wallace L 1990 Reshaping technical assistance *Finance and Development* 27(4) 26 30

World Bank 1988 *National Agricultural and Livestock Research Project* Report No 6926 TA Washington D C

Smallholder Irrigation Development Impact on Productivity, Food Production, Income, and Employment

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SUMMARY

Smallholder irrigation is still a small factor in the performance of agriculture in Zimbabwe, but it has a potential to raise the overall contribution of agriculture because it is cheaper than the present dominant large-scale irrigation

In Zimbabwe, the lack of information on smallholder irrigation development has adversely affected policy, design, and irrigation planning, contributing to poor understanding of the smallholder irrigation sub-sector

This study used a comparative research approach to analyze the performance of irrigation and nonirrigation systems in an effort to highlight the importance of smallholder irrigation

Survey data were collected from 40 households in eight irrigation schemes and 40 nonirrigation households in adjoining communal areas From each respondent, information was collected on crops and output, input costs, livestock, income, remittances employment, food situation, labor, and gender issues Both quantitative and qualitative data were collected through the use of a questionnaire and informal discussions

The study showed that agronomic conditions including rainfall and availability of water tend to determine the extent to which a crop is grown as a cash crop It was observed that there was little variation in the types of cash crops grown by nonirrigating smallholder farmers However, irrigation has allowed the irrigating smallholders to have two croppings per year and to diversify the range of cash crops into high value horticultural crops

The smallholders in both irrigation schemes and dryland communal areas used low fertilization rates due to inadequate credit About 60% used retained seed for the same reason

While 58% of the total area of irrigating and nonirrigating systems was under maize, the irrigating farmers tended to grow all their food crops on dryland fields within the schemes On the other hand the nonirrigating farmers grew more diversified food crops In both cases it was mainly the women who grew food crops

The collected data showed that irrigating households had a higher percentage of externally sourced food Irrigating households tended to maximize income from their irrigated plots In contrast, nonirrigating households aimed to minimize food purchases because of low incomes from their crops The nonirrigating households obtained most of their food from drought relief and remittances The nonirrigating households had more relatives in formal employment in urban areas who were able to remit food or money to purchase food

For reasons that include the need to have sufficient family labor to work in the irrigation plots, the irrigating households were shown to have greater family sizes As a consequence they have a lower food supply per capita than nonirrigating households As such, irrigation development policy should address the issue of food security The availability of food supplies within irrigation schemes should be given priority because the irrigators with their high purchasing power are in a better position to purchase food

For both irrigating and nonirrigating households, crop income was dominant While the irrigating farmers received higher incomes from the high value crops, their costs of inputs were also higher The nonirrigating farmers had a higher share of their income from nonfarm sources, mainly remittances In general per capita income was higher for irrigating households despite the fact that their costs of production were greater than those of the nonirrigating households

The irrigating farmers employed more family and hired labor mainly from nonirrigating households This shows the significance of smallholder irrigation schemes to employment Much of the employment is created in winter during the time when the nonirrigating households are not busy and are experiencing slack demand for their labor

The study showed that irrigating households had fewer female heads One reason is that government policy on allocation of irrigation permits favors men On the other hand there were more women heads of households among the nonirrigating farmers In general the women in nonirrigating households had access to special plots in which they grew food crops This suggests that the status of women has not improved with the irrigation projects because access to land has diminished and their role in decision making within the households remains insignificant

Droughts inflict hardships on Zimbabwe an economy in which agriculture normally provides most food requirements, half of the merchandise exports and a major share of the employment Smallholder irrigation development offers one potential strategy to improve the performance of the agricultural sector in Zimbabwe leading to an improvement in the general economy Large-scale irrigation which has received the bulk of the investments, water and land resources due to colonial legacy has failed to deal with the problems of droughts Although smallholder irrigation currently makes a small contribution to the performance of agriculture it is cheaper than the dominant large-scale irrigation

Policy makers believe that irrigation, adequately executed and supported by proper pricing policies and sound technical and socioeconomic conditions can transform the production potential of agriculture This, they contend, offers the best prospect for food security and self-sufficiency at household, national, and regional levels

In Zimbabwe, there is little information on small-scale irrigation development The few studies done by consultants have been disjointed and focused mainly on large scale irrigation This lack of information has adversely affected policy design and irrigation planning contributing to poor understanding of the small-scale irrigation subsector

Recently an irrigation project was started at the University of Zimbabwe A new division on irrigation has also been set up with the Department of Agricultural Technical and Extension Services (Agritex) within the Ministry of Lands Agriculture and Water Development However, all these developments focus on the technical aspects of the development of small-scale irrigation As such no comprehensive university course encompassing socioeconomic aspects of small-scale irrigation development has been established Similarly the capability of Agritex to plan and provide extension services to small-scale irrigation schemes is limited because socioeconomic factors are not adequately understood

This study assesses the prospects of smallholder irrigation for increasing cash and food production and improving the reliability of food supply to achieve food self-sufficiency at the household level Better understanding of the socioeconomic infrastructure for smallholder irrigation would allow the identification of factors that prevent irrigation from efficiently contributing to increased food and cash

crop production Possible policy options that could raise the potential of irrigation to contribute to increased productivity, income, and employment generation would then be identified

This study is also intended to promote discussion on smallholder irrigation and to consolidate information for both policy design and establishing a course on small-scale irrigation development at the University of Zimbabwe

The following hypotheses were tested

- Yields of cash crops for smallholder farmers with irrigated enterprises are higher than for those without irrigation
- Yields of food crops for smallholders with irrigated enterprises are lower than for those without irrigation
- Irrigating smallholder farmers have lower household food consumption per capita than nonirrigating smallholders
- Household per capita income is higher for smallholders with irrigated enterprises than for those without irrigation
- Smallholders with irrigated enterprises employ more hired and family labor than those without irrigation

It is the broad assumption of the study that in addition to solving the problems of agriculture related to unreliable rainfall, the development of smallholder irrigation would also contribute to the redistribution of land to the smallholders who are also known for being more efficient producers than the large-scale commercial farmers

The Agricultural Sector

Agriculture has been the backbone of the economy Although its contribution to GDP has declined due to drought and world recession and is below the 29% contribution by the manufacturing sector, agriculture continues to supply the manufacturing sector with raw materials About 50% of the manufacturing sector relies on agriculture for inputs Also, over 70% of the population lives in rural areas and their main livelihood is agriculture In addition, the growth of the economy is tied to the performance of the agricultural sector, which provides more than 90% of the food requirements and accounts for 48% of total merchandise export earnings

Of great significance is the growth in the importance of smallholder farmers, whose production of key crops such as maize and cotton has overtaken that of large-scale commercial farmers This increase in production by smallholder farmers enabled the country to increase its agricultural exports by 6% to 7% annually (1980-85)and also to expand the processing of agricultural raw materials

Compared with the manufacturing sector, which employed 167,000 persons in 1984 and 190,000 in 1990, the agricultural sector employed 262 000 persons in 1984 and 290,000 in 1990, accounting for approximately 60% of formal employment in those years This shows the importance of agriculture as a dominant sector in the generation of employment

It is projected that employment in the agricultural sector will increase at an average annual rate of 2 2% This increase is expected to occur mainly in the subsectors using labor-intensive production techniques such as horticulture and smallholder irrigation

Food production by the smallholder subsector has been growing at 7% a year Of the total maize output of 3 5 million tons yearly, approximately two-thirds is produced by smallholder farmers

Despite important successes in maize and cotton production since independence, the agricultural sector is often regarded as not having fulfilled its potential The growth of agricultural output in constant prices between 1980 and 1988 was 2 2% a year, well below the estimated 3% annual growth of population during the same period The sector problems arise mainly from the world recession which affect the prices of the agricultural exports the drought resulting in variable output, poor support services, and low investments

The Zimbabwean economy is characterized by heavy reliance on the export of raw materials, a high degree of technological dependence on the outside world, and a relatively high rate of population growth, which reached 3 1% in 1992 (CSO 1992)

Any analysis of agriculture in Zimbabwe would show that the sector is also characterized by the pervasive dualism, the result of public policy dur-

Table 1 Evolution of government irrigation policy and effects in Zimbabwe since 1912

Period	Policy objectives and effects
1912 27	Missionaries introduce irrigation into indigenous agriculture
1928 34	Government provides services to develop irrigation schemes but farmers retain control
1935 45	Government takes over and manages schemes introducing restrictive regulations
1946 56	Land Apportionment Act of 1930 is amended and blacks are moved to Native Reserves New irrigation schemes are created to help settle black farmers
1957 65	Government investigates economic viability of schemes and this slows down development of new schemes
1966 80	Government introduces the policy of separate development for blacks and whites and the strategy of rural growth points mostly based on irrigation
1981 date	Policy moves toward decreasing government subsidies on existing schemes and requires financial viability for new schemes

Source Roder 1965 Rukuni 1984

ing the colonial period Approximately 4 500 large-scale commercial farmers control 29% of the nation s land area located mainly in the region with the highest and most reliable rainfall and best soils

Prior to independence the major part of public resources was geared to supporting the large-scale commercial subsector Only limited assistance was given to the smallholders in communal areas Since independence the objective has been to redress this situation

Agricultural extension services are now mainly oriented toward the smallholders but the main problem is that much of the extension staff is inexperienced The emphasis is on in service training and improving the worker-to-farmer ratio from 1 1 000 in 1980 to 1 600

Zimbabwe s agricultural policy today is heavily influenced by its past The government has enunciated various policies since independence intended to increase the role of agriculture as a major foreign exchange earner and a source of inputs for local industries to achieve food self sufficiency and to increase employment

The Irrigation Subsector

Zimbabwe inherited a dual irrigation structure The larger irrigation schemes were designed for commercial large-scale production of cash crops while the smaller ones were smallholder schemes largely based on production of food crops for home consumption

Small scale irrigation schemes introduced into Zimbabwe s rural areas more than 60 years ago, were intended to assist in local food production provide employment and reduce the need for famine relief In smallholder irrigation schemes, each farmer has less than a hectare under irrigation The scheme is operated by the smallholders themselves through a community type of management By contrast large-scale irrigation schemes have external management and the typical farmer operates thousands of hectares of land

The government has been particularly interested in the development of irrigation to reduce dependency on rainfed agriculture which is vulnerable to droughts Second it is concerned with the need to solve the food crisis Scarce foreign exchange is being used to import food while the supply of food to rural populations is inadequate and unreliable Also the government would like to see agriculture supplying inputs to the manufacturing sector and generating foreign exchange and employment

At present more than 7 200 families are engaged in smallholder irrigation There are 92 operational smallholder irrigation schemes occupying 4 572 hectares with a further 14 schemes on 605 hectares being rehabilitated Sixteen schemes covering 2,054 hectares are being planned The area under smallholder irrigation is expected to reach 10,000 hectares by 1995

In smallholder schemes farmers are allocated plots varying from 0 1 to 1 0 hectares, averaging about 0 5 hectare per smallholder Schemes in which farmers are allocated plots as small as 0 1 hectare are supplementary schemes, designed as a form of a drought relief Their economic justification is that other forms of famine relief are less efficient and more expensive Irrigation schemes with larger plots are justified in terms of increased agricultural production and are intended to be financially viable About 35% of irrigation schemes in communal areas are each below 20 hectares

In 1982 land suitable for irrigation was estimated at about 550 000 hectares with total natural surface water resources of 1 310 x 10^9 cubic meters Only 360 x 10^9 cubic meters have been developed to sufficiently irrigate 200 000 hectares in

commercial farming areas and up to 30,000 hectares in communal lands

An understanding of the evolution of smallholder irrigation in Zimbabwe is critical for judging the potential role of smallholders in reducing the dependency on rainfed agriculture Table 1 summarizes government irrigation policy interventions from a historical perspective

The Unilateral Declaration of Independence period, 1966 to 1980, saw a change in policy, with the government supporting irrigation schemes around the rural growth points The aim was to facilitate separate development from white areas The government set up a parastatal, the Tribal Trustlands Development Corporation to develop growth points in communal lands where smallholder farmers are concentrated The growth points based on irrigation were designed to have a large 'core estate" to provide services to settlers

Little investment in smallholder irrigation has taken place since 1980 because, with policy makers placing more importance on financial viability, most potential schemes have failed to meet the criteria for funding

The National Farm Irrigation Fund earmarked approximately Z$6 million out of the Z$18 million for funding smallholder irrigation schemes appraised to be financially viable Because of the traditional communal land tenure system in these areas, few small farmers have managed to borrow funds as a group for developing in-field works in these smallholder schemes

The history of smallholder irrigation development has been characterized by lack of institutional stability in the agencies providing extension and management services Table 2 gives the organizational history of smallholder irrigation development in terms of the provision of extension and management services by the various government agencies This phenomenon has slowed the development of institutional capacity for both the agencies and the smallholder irrigation schemes, contributing to poor performance and productivity However, the government has continued to support irrigation development through various agencies The Department of Rural Development in the Ministry of Local Government, Rural and Urban Development provides design and management services to irrigation schemes smaller than 500 hectares The Agricultural Development Authority a parastatal in the Ministry of Lands, Agriculture, and Water Development (MLAWD), is responsible for the development of commercial irrigation schemes larger than 500 hectares Agritex is responsible for the provision of extension services to all the irrigation schemes The MLAWD is responsible for dam construction and supply of water to field edge, while the Public Services Investment Programme, managed by the Ministry of Finance, provides funds for pipes and laying of pipes up to the edges of the schemes

Table 2 Government agencies responsible for managing irrigation schemes (M) and providing extension services (E) in Zimbabwe since 1932

Period	Government agency	Functions
1932 44	Ministry of African Affairs	E & M
1945 63	Internal Affairs Administration	M
1951 63	Dept of Native Agriculture	M
1964-68	Dept of Conservation and Extension	E & M
1969 78	Ministry of Internal Affairs	E & M
1978 81	Dept of Agricultural Development	E & M
1981 85	Dept of Rural Development	E & M
	Agritex	E
1985 date	Agritex	E & M

Source Rukuni 1984

Literature Review

In their search for irrigation financing policies, Small and Carruthers (1990) reported that irrigation is important and becoming crucial to food security, employment, and income growth in poor countries

> Irrigation provides supplementary water supply to one-fifth of the world s cultivated land But one-third of the world s food is harvested from this irrigated land Many of the world s poorest people are dependent on this food Even more important perhaps is the fact that nearly three quarters of incremental agricultural production comes from irrigated land In the very large developing countries like China India Indonesia and Pakistan half of all agricultural investment goes into irrigation Some 25 to 30% of World Bank agricultural lending is allocated to irrigation and billions of low income people struggle to supplement inadequate and unreliable rainfall with irrigation

African countries are conspicuous for not having irrigation policies, with the exception of a few like Egypt that have no real choice but to embrace irri-

gation if they intend to develop their agricultural sector Africa s 51 developing countries have 9 million hectares under irrigation representing only 5% of the total cultivated land but the value of the production from irrigation (without fodder crops) is about 20% of the total crop value (Horning 1987)

Repetto (1986) noted that worldwide irrigation achievements have been considerable More ample and assured supplies of water have enabled farmers to shift from hardy but low valued crops such as oilseeds millets and sorghum to more valuable crops such as wheat and rice and have emboldened farmers to use new high yielding seeds that respond well to heavy fertilization Farmers have been able to break the constraints of rainfall on cropping patterns and harvest two or even three crops a year from the same land Repetto further agreed that in the package of inputs that produced the green revolution irrigation was a critical component

In his evaluation of large public irrigation systems Repetto (1986) showed that in most cases service had deteriorated due to faulty design and construction neglected maintenance and poor operation Apart from the weak performance, their contribution to agricultural growth has, compared with that of small scale and private irrigation, been less than is usually assumed

Morris (1987) an American engineer who was an area manager for Africa at a major international water resources consulting seminar wrote None of the water experts contacted could point to any of the large agricultural irrigation projects built over the past 10 years in black Africa that has made a dent in the current famine He further indicated that African nations have borne the brunt of a lot of bad advice bad engineering and bad intentions and they are paying the price for it now

A USAID report concluded that under Africa s present economic difficulties large-scale irrigation is economically inappropriate in five respects (USAID 1987)

1 It usually requires a large injection of scarce hard currency during initial construction
2 The machinery installed (pumps grain dryers etc) will require continuing hard currency support throughout the lifetime of the project
3 High input farming needed to achieve high yields has a high import content
4 Projects located at remote sites will incur high transport costs
5 Most large-scale schemes are provided with expatriate staff generating further losses of hard currency

Since large-scale irrigation systems have proved to be high cost and high import content technology, it is imperative that less expensive and more sustainable types of irrigation be devised that are suited to smallholders

Indeed the deteriorating economic situation in many sub-Saharan countries makes a reassessment of investment priorities for agricultural development mandatory Moris and Norman (1984) highlighted the policy issues that should be addressed in developing irrigation in Africa as shown in table 3

Methodology

Survey areas

The survey areas consist of eight smallholder irrigation schemes in eight provinces A random sample of the nonirrigating smallholder farmers in the dryland areas adjacent to each irrigation scheme was included in the study Each dryland area had the same agro-ecological and climatic conditions as the corresponding irrigation scheme

Sample selection

The sampling frame was prepared from a list of existing smallholder irrigation schemes This sampling frame was stratified by province and one irrigation scheme was randomly selected from each province For each of the selected smallholder schemes, a list of all the households was prepared from which five households were randomly selected to end up with a total of 40 irrigating households Using a systematic random selection procedure, a total of five nonirrigating households was obtained from the communal areas adjacent to each irrigation scheme In all, a sample comprising 40 irrigating households and 40 nonirrigating households was used for the study

Data collection

Both qualitative and quantitative data were collected Qualitative data provided descriptive infor-

mation while quantitative data was in a variety of forms Data on crop output and cropped areas were obtained to calculate yield data for cash and food crops Data were also collected on income and input costs to estimate the net disposal income to households The collected family size data allowed the calculation of per capita quantities Other types of quantitative data were collected on household labor food consumption, and sources of food to determine food security and self-sufficiency levels

Quantitative data were collected by means of questionnaire interview from the selected households in irrigation schemes and surrounding dryland areas The questionnaire had been pretested to improve its accuracy It was found convenient to interview two members of each household (the head of household and spouse) in order to improve the accuracy of the data and reduce the problem of memory lapses

Respondents were given the freedom to express output and other variables in locally known units With the assistance of agricultural extension officers, conversion factors were obtained to convert the data to standard units

Informal discussions with respondents and government officials were conducted to probe further into salient study issues Besides the interviews and informal discussions, other methods including observations and review of farm records were used to collect useful data

Data analysis

Each of the 80 questionnaires was coded and all questions in a questionnaire including the verbal open-ended answers were coded to come up with a master code list Continuous data was also classified into specific classes of known ranges and coded

Analysis was divided into exploratory data analysis and the more elaborate techniques of analysis establishing statistical associations between pairs of variables in a multivariate context

Relationships for defined variables were established The analysis yielded descriptive statistics of frequency counts and tables, averages and proportions, as well as cross-tabulations and correlations of variables that enabled the statistical testing of hypotheses

Standard *t*-tests and Chi-square analyses were used as tests for the hypotheses The qualitative aspect of analysis complemented the quantitative one in an attempt to determine nonquantifiable relationships

Study Results

Cash crop production

In summer, the important cash crops for smallholders in irrigation schemes are maize, edible dry beans, groundnuts, and cotton, which are grown with supplementary irrigation About half of the schemes also grow green maize, potatoes, and mixed vegetables, such as cabbage, okra, and onion, as summer cash crops with supplementary irrigation The schemes have their second crop under full irrigation in winter between May and August

Table 3 Key irrigation policy questions and issues

Food Policy
- Consumption trends Which staples
- Produce at home or buy from abroad
- What fluctuations tolerable
- Pricing policy
- What urban/rural subsidies

Balance between Irrigated versus Rainfed Farming
- Comparative costs of production by zone
- What import content in production
- Comparative transport costs
- What technical opportunities for each
- What role in supporting population intensification
- What complementarities

What Kinds of Irrigation
- Large scale versus small scale formal versus nonformal
- Full versus partial total versus supplementary
- Authority managed versus locally managed
- Supply and conveyance options

What Crops
- Present yields irrigated versus nonirrigated
- Cost/price trends internal and external
- Available technical packages input implications
- Foreign exchange implications
- Food security implications
- Integration between enterprises

Where When and with Whom
- Phases in development
- Location of projects
- Acquisition of right
- Infrastructural costs
- Cost recovery mechanisms
- Is settlement included
- Sources of staff expertise
- Supervisory structures
- Farmer participation

Source Adapted from Moris and Norman 1984

Table 4 Average yields for cash crops grown by irrigating and nonirrigating smallholders

Crop	Yield (t/ha)		
	Irrigating	Nonirrigating	Difference
Grain maize	5 44	3 41	2 03
Cotton	1 90	0 99	0 91
Groundnuts (unshelled)	1 58	0 73	0 85
Edible dry beans	0 60	0 53	0 07

They grow wheat onion cabbages dry beans, potatoes, green maize, and tomatoes Potatoes and grain maize are treated as both cash and food crops by most farmers A number of the plotholders maintain dryland fields within the irrigation schemes on which in summer they grow such crops as maize groundnuts rapoko sunflower and bambara nuts under rainfed conditions

On the other hand for 91% of the nonirrigating farmers the major cash crops are maize cotton, and sunflower which are grown in the summer As in the irrigation schemes, maize is treated as both a food and cash crop Cash crops of lesser importance include groundnuts and sorghum which are also consumed by the households Tobacco and soya beans are other cash crops grown on a limited scale

Agronomic conditions including rainfall and the availability of water in irrigation schemes tend to determine the extent to which a crop is grown as a cash crop The observed impact of irrigation has been to allow the smallholder to have two cropings per year Irrigation has also allowed smallholders to diversify into high value horticultural crops

The smallholders in both irrigation schemes and dryland communal areas reported low fertilization rates due to inadequate credit About 60% use retained seed for the same reason They have even reduced their seeding rates for most crops

Table 5 Average yields of food crops for irrigating and nonirrigating smallholders

Crop	Yield (t/ha)		
	Irrigating	Nonirrigating	Difference
Grain maize	2 50	3 21	(0 71)
Groundnuts (unshelled)	0 70	0 78	(0 08)
Rapoko	0 90	0 46	0 44
Bambara nuts	0 40	0 38	0 02
Potatoes	2 38	2 25	0 13
Soya beans	1 20	0 86	0 34

Table 4 supports the hypothesis that yields of cash crops for smallholder farmers with irrigated enterprises are higher than for those without irrigation The irrigating smallholder farmers are likely to have higher yields because of greater intensity of crop production in the irrigation schemes on their 0 5 hectare plots It appears that to achieve higher incomes the irrigators maximize yields on the irrigated plots to cover the additional costs of energy and water One way of maximizing yields is to concentrate crop inputs such as fertilizers and chemicals on the small irrigation plots Since most of the irrigating smallholders use less than recommended input rates that suggests that the schemes still have underutilized potential to raise cash crop yields

Food production

In summer the irrigating smallholders grow all their food crops under rainfed conditions on dryland fields within the schemes The crops grown include grain maize groundnuts rapoko potatoes, soya beans, and bambara nuts The nonirrigating smallholders grow a number of food crops—maize, groundnuts sorghum roundnuts millets cowpeas, rapoko soya beans potatoes sweet potatoes rice, and edible beans Maize the staple food is the most important food crop for both irrigating and

Table 6 Sources of household food

Scheme/area	External source (%)		Produced by household (%)	
	Irrigating	Nonirrigating	Irrigating	Nonirrigating
Chibuwe	40	38	60	62
Fanisoni	43	21	57	79
Gowe	22	10	78	90
Hoyuyu	16	30	84	70
Mwerahari	35	22	65	78
Nzinyatini	41	34	59	66
Rukunguhwe	52	27	48	73
St Joseph	30	23	70	77
Avg	35	26	65	74

nonirrigating smallholders About 58% of the total area is planted to maize

In winter, the irrigating smallholders consume some of their irrigated cash crops, notably potatoes, maize and horticultural crops The nonirrigating farmers grow a number of their food crops, mainly cabbage, onions, potatoes, and green maize, in their gardens under some form of traditional irrigation It is mostly women who grow these food crops The average yields shown in table 5 takes into account the food crops grown in gardens by nonirrigating farmers The minor yield differences for irrigating and nonirrigating farmers may indicate that they have the same level of management skills The study expected to observe lower yields for irrigating farmers who give more attention to cash crops in the irrigated plots

Statistical tests provided no support for the hypothesis that yields of food crops for smallholders with irrigated enterprises are lower than for those lacking irrigation Apparently irrigating smallholders still manage food crops to achieve yields comparable to those of the nonirrigating farmers

It can then be concluded that irrigation has not adversely affected food production as the irrigating smallholders intensify cash crop production on their 0 5 hectare plots They continue to maintain and achieve high yields for food crops in the dryland fields within the schemes

Household food situation

The surveyed households reported making cash purchases of food from the local market to meet their household consumption needs

All households strive to produce their own food (table 6) The high proportion of produced food reflects the degree of uncertainty in local food markets It means that smallholders consider food self-sufficiency more critical than just achieving food security as they attempt to avoid the risk of food shortages in the local market It can be argued that this fear of food shortages affects smallholders decision to expand cash crop production in the communal areas

Table 7 shows that on average irrigating small holders purchase a higher percentage of food from the local market This may be due to the high purchasing power of the irrigating smallholders de rived from cash crop sales

For irrigating households drought relief is the least important source of external food (13% compared with 33% for nonirrigating households) This observation may reflect government policy which appears to view the dryland farmers in communal areas as needing the most assistance in the form of drought relief

The nonirrigating households, on the other hand are observed to have a higher proportion of remitted food (38%) than the irrigating households (24%) The nonirrigating households are long established with more members employed in urban areas who are able to remit the needed food during times of shortage

Food consumption per capita

The average family in Zimbabwe has six members, and low income groups tend to have the largest families In the study the average irrigating household had nine family members and nonirrigating households had seven members The nonirrigating households had a higher food supply per capita because of the lower average family size (table 8)

Food security is defined in this study as access by all people at all times to enough food for an ac-

Table 7 Purchased remitted, and drought-relief food as a proportion of all food acquired from external sources

	Purchased food (%)		Remitted food (%)		Relief food (%)	
Scheme/area	Irrigating	Nonirrigating	Irrigating	Nonirrigating	Irrigating	Nonirrigating
Chibuwe	68	39	22	36	10	25
Fanisoni	51	39	28	31	21	30
Gowe	70	48	28	24	2	28
Hoyuyu	65	15	24	45	11	40
Mwerahari	53	10	21	52	26	38
Nzinyatini	60	26	30	48	10	26
Rukunguhwe	72	27	26	40	2	33
St Joseph	66	32	14	26	20	42
Avg	63	29	24	38	13	33

Table 8 Family food (grain and meal) consumption

	Irrigating households			Nonirrigating households		
Scheme/area	Total (kg)	Family size (no)	Food per capita (kg)	Total (kg)	Family size (no)	Food per capita (kg)
Chibuwe	1 080	12	90	1 214	8	152
Fanisoni	2 100	8	263	1 831	7	262
Gowe	1 115	10	112	2 150	6	358
Hoyuyu	1 000	9	111	2 053	8	257
Mweraharı	1 019	11	93	1 569	9	174
Nzinyatini	989	8	124	1 972	6	329
Rukunguhwe	1 200	7	171	1 486	5	297
St Joseph	2 000	7	286	1 961	7	280
Avg	1 313	9	146	1 780	7	254

tive healthy life (Reutlinger 1987) The study found that the surveyed households strive to achieve food security by making use of their own production by purchasing food and by taking advantage of directly received food in the form of remittances and drought relief It is crucial that the households have an adequate and reliable supply of food with a guaranteed ability to acquire it This ability leads to food self-sufficiency for the households

Table 8 suggests that irrigating households are more likely to face food insecurity than nonirrigating households The implications are that irrigation development policy should consider food security issues critically

The analysis confirms the findings of other research studies that up to about 40% of the communal area families have to purchase additional staple grain on the market every year (Rukuni 1990) Low productivity and inadequate purchasing power among the poor are commonly cited as the reasons why food insecurity persists Similarly field research in two communal areas of Zimbabwe indicated that in a good harvest year 59% of farm households surveyed did not produce enough food for family requirements (Jayne et al 1990)

Farm and nonfarm income

In both irrigating and nonirrigating households crop sales are the dominant source of income Crops provide an average of 60% of the income and the rest comes from livestock, which includes sale of cattle goats and chicken In irrigating households, farm sales are dominated by horticultural products which include green maize, cabbages, tomatoes okra onion, and spice On the other hand, for nonirrigating households grain maize dominates the crop sales For a few nonirrigating households tobacco, mainly burley variety, dominates the farm sales

Particularly for nonirrigating farmers, remittances are a major source of nonfarm income Non irrigating households are mostly older and hence have more members in formal employment to supply with this income

For nonirrigating households wages are an important source of nonfarm income The wages consist of income from both formal and informal employment and from hiring out to work during peak seasons in the irrigation schemes The majority of irrigating households receive income from blacksmithing This may stem from the apparent greater demand for farm tools in irrigation schemes than in the nonirrigating areas

About 15% of the nonirrigating smallholders derive their nonfarm income from beer sales compared with 3% for irrigating households Irrigating households are busy throughout the year because they grow winter crops so they have less drinking time compared with the nonirrigating smallholders for whom labor demand is lower in the winter season

Table 9 Per capita income (Z$)

Scheme/	Irrigating households		Nonirrigating households	
area	Net income	Per capita	Net Income	Per capita
Chibuwe	1 815	151	541	68
Fanisoni	2 300	288	780	111
Gowe	1 223	122	1 897	316
Hoyuyu	972	108	863	108
Mweraharı	1 794	163	1 628	181
Nzinyatini	2 146	268	755	126
Rukunguhwe	2 005	286	1 876	375
St Joseph	1 819	260	901	129
Avg	1 759	195	1 155	165

Per capita income

Irrigating households have relatively higher incomes than nonirrigating households (Table 9) On the other hand, the few nonirrigating households that grow tobacco can get higher incomes than irrigating households It is surprising that in spite of the high income from tobacco the surveyed irrigating households prefer to grow horticultural crops They may avoid tobacco because it is labor intensive Also tobacco cannot be grown in the winter season when cheap labor from nonirrigating smallholders would be available Table 9 shows that on average irrigating farmers have higher per capita incomes If irrigating smallholders were to shift into tobacco production their per capita incomes would further improve

Family labor and employment generation

Family labor

Family size has a direct relationship to the availability of labor Polygamous families have as many as 20 members in some instances Irrigating households have a larger proportion of polygamous families Thirty-two percent of the surveyed heads of households reported having two or more wives In the nonirrigating households, only 19% are polygamous

Data on the family labor use (table 10) suggests the most demanding tasks are harvesting and weeding For irrigating households harvesting requires 320 man-days and weeding, 210 man-days But for nonirrigating households, weeding has the greatest demand, 226 man-days, followed by harvesting with 112 man-days In general irrigating smallholders use more labor (974 man-days) than nonirrigating households (682 man-days)

Table 10 Family labor demand per household

	Family labor (man days)	
Task	Irrigating	Nonirrigating
Weeding	210	226
Plowing	22	109
Planting	150	82
Harvesting	320	112
Other	272	153
Total	974	682

Note A man day is taken to mean 8 hours of work by one laborer on a single task

For both irrigating and nonirrigating households women and children provide the much-needed labor for weeding, harvesting, and planting while men provide the labor for plowing

Hired labor

About 37% of irrigating smallholders reported labor shortages compared with 12% of nonirrigating smallholders Labor shortages affect mainly weeding and harvesting and occur in winter

The demand for hired labor is different for irrigating and nonirrigating smallholders (table 11) On average, irrigating households hire 818 man-days of labor compared with only 125 man-days for nonirrigating households Among the nonirrigating households the main employers of hired labor are the tobacco growers For the irrigating and nonirrigating households hired labor is employed in weeding, harvesting, and other tasks, but for the tobacco growers, hired labor is primarily used in picking and grading tobacco

About 90% of hired labor comes from nonirrigating households and the balance from neighboring commercial farms and other irrigating households This shows the importance of smallholder irrigation in generating employment, allowing nonirrigating households to earn regular incomes during winter when the demand for hired labor is low elsewhere

Hired labor is mainly paid in cash for irrigating and nonirrigating households For nonirrigating households, in-kind payment ranks second, mostly in form of food and clothes received as remittances from relatives in formal employment in towns The other' payment includes labor exchanges and sharing and the exchange of hired labor for draught power to till the land

Gender

Females constituted 12% of all the heads of households in the study Among the female household heads, 78% are in nonirrigating households

Table 11 Labor hired per household

	Hired labor (man days)	
Task	Irrigating	Nonirrigating
Weeding	236	82
Plowing	42	0
Planting	76	0
Harvesting	277	31
Other	187	12
Total	818	125

ind only 22% are in irrigating households There are fewer female heads among the irrigating households because of the government policy of allocating irrigation plots only to males There are more female heads among the nonirrigating households because the lower incomes from crops and other sources characteristic of the dryland area economy encourages males to seek formal employment As a result, more women become de facto heads of households This is shown by more remittances being received by nonirrigating households from towns

All the female heads among the irrigating house holds were de jure—mostly widows occupying plots of their deceased husbands Of the female heads among the nonirrigating households 91% are de facto heads representing their husbands who work in formal employment in urban areas and only 9% are de jure heads

The study found that 25% of the women in nonirrigating households have access to special plots that are allocated to them by the men In contrast less than 6% of the women in irrigating households have access to such plots mostly in the dryland area within the schemes Among the women with special plots 86% have plots of less than 0 5 hectare The women grow mainly food crops on these special plots (table 12)

There is an observed emerging division of labor in which men own land ind make household deci sions to grow cash crops and women provide their labor to men s fields and crops The women also grow food crops in their gardens to maximize food security and self sufficiency while men maximize incomes from the sale of cash crops

Table 12 Crops grown in women's special plots

Crop	Plots (%)
Maize	62
Groundnuts	45
Sorghum	38
Roundnuts	29
Millets	17
Sunflower	9
Cowpeas	8
Rapoko	5
Edible beans	5
Cotton	3
Soya beans	2
Sweet potato	1

Conclusions

The development of smallholder irrigation is an attempt to deal with the problems of frequent droughts ind unequal ownership of productive resources and inequitable provision of services Smallholder irrigation development allows redistribution of land to small farmers and ensures higher productivity or efficient use of land and water resources

The potential of smallholder irrigation is yet to be fully achieved More smallholder farmers need to be settled in irrigation schemes to exploit the abundant resources in the agriculture sector Institutional arrangements for smallholder irrigation development are weak Both extension and research services are poorly developed More investment in the irrigation subsector is needed

Examples from other countries show that while the cost of developing smallholder irrigation is high future benefits outweigh the costs In Zimbabwe, policies have been poorly formulated because of scarcity of information on the performance of irrigation With little information and poor policies badly designed irrigation projects emerged that have failed to address the problems and needs of the smallholder farmers who are the majority in the rural areas

Available literature in Zimbabwe indicates that a number of irrigation schemes were started by smallholders to deal with problems of food security Later with government intervention and public investment, these smallholder schemes ceased to address the needs of the grassroots communities The schemes have, with time shifted from food production to cash crop production as a result of pressure on the smallholder to meet operational costs

Irrigators maximize their use of land resource by intensifying the production of cash crops, mostly high-value horticultural crops They have two croppings a year while nonirrigating smallholders grow mainly food crops of low value in summer Irrigating smallholders appear to be under pressure to achieve higher yields in order to meet the high production costs for these cash crops On the other hand, tobacco, a high value but labor-intensive crop is mainly grown by nonirrigating smallholders The irrigating smallholder farmers achieve the

same yields for food crops as the nonirrigating smallholders

Irrigating smallholders have larger families, resulting in lower per capita food consumption for the household members Irrigating smallholders rely more on purchased food while nonirrigating farmers produce more of their own food apart from receiving a higher proportion of remitted food from household members in formal employment This is because the low and unreliable incomes for the nonirrigating smallholders make them think of alternative sources of food Also nonirrigating smallholders have more diversified sources of food, including drought relief food in times of shortage

Agriculture dominates the rural economy Livestock appears to be a secondary source of income after the sale of cash crops Irrigating smallholders have higher incomes than nonirrigating smallholders, with the exception of nonirrigating tobacco growers, who have even higher incomes Remittances are a dominant source of nonfarm income They are mostly received by nonirrigating smallholders, who have more household members in formal employment

Children and women provide much of family labor for most productive tasks, mainly harvesting and weeding Men, on the other hand, provide labor for plowing Because of the great intensity of work in irrigation plots, demand for hired labor is greater for irrigating smallholders Tobacco growers also employ more labor

Hired labor comes mainly from the nonirrigating households during winter Commercial farms also supply a significant proportion of hired labor This underscores the importance of smallholder irrigation in generating employment for the rural population

Most hired labor is paid in cash In-kind payment is more important with nonirrigating smallholders who pay with food and clothes that have been remitted from household members in urban areas

Heads of households in nonirrigating households are mostly in formal employment because of the low productivity of agriculture The women are often the de facto heads of households and regularly receive remittances from their husbands to support their families

Women in irrigation schemes have little household decision-making role and have no access to land, apart from providing their labor to work in the plots On the other hand, in nonirrigating households where more women are de facto heads, women are more likely to have a decision-making role and access to gardens on which they grow food crops Smallholder irrigation projects are undermining the status of women

Recommendations

Smallholder irrigation should be expanded through the creation of new schemes and the rehabilitation of the existing ones There are still unexploited water and irrigable land resources available to a greater part of the rural population Smallholder irrigation has the potential to alleviate population pressure in the rural areas and create employment Its expansion would also reduce the dependence of agriculture on unreliable rainfall Government should continue constructing small dams throughout the country, a program on which smallholder irrigation development is based

The expansion of smallholder irrigation should emphasize community-managed smallholder irrigation schemes These schemes are cheaper and have a better chance of meeting the needs of the smallholders

The capacity of Agritex to provide extension and monitoring services to smallholder irrigation schemes should be strengthened through staff training, increased staffing, and provision of vehicles for better extension contacts Extension would improve management of smallholder irrigation schemes by smallholders themselves, avoiding breakdowns in irrigation pipes, etc

The University of Zimbabwe and other interested institutions should regularly undertake coordinated evaluation and review studies to improve the performance of smallholder irrigation This would also ensure that a database is created to improve policy formulation and project design and implementation

Research should be conducted by the Institute of Agricultural Engineering and Department of Research and Specialist Services to identify appropriate technologies that can be used by irrigating smallholders to mechanize labor-intensive tasks

such as weeding and harvesting to lessen pressure to have large families to supply labor However, research into appropriate technologies should strive to achieve a balance between reducing the demand for family labor and ensuring that smallholder irrigation continues to generate employment for rural population

Both irrigating and nonirrigating smallholders should be encouraged to grow tobacco through the provision of credit and extension services This would raise their incomes Researchers should investigate how tobacco can be grown on a small-scale and cost effective basis by the irrigating farmers

Livestock remains an insignificant source of income However technologies such as pen fattening should be encouraged to raise the importance of livestock while ensuring that it does not increase competition with crop production for land This is particularly critical in irrigation schemes where land is a limiting factor

The nonirrigating smallholders should be provided with more information to identify other non-farming income-generating activities such as blacksmithing to enable them to diversify their incomes

Gender policies that are different for irrigating and nonirrigating smallholders should be designed The policies for nonirrigating smallholders should focus on providing support services such as extension to women to make them more productive while those for irrigating smallholders should focus on improving the access of women to economic resources such as irrigation plots to bring women into economic development

It is clear that the smallholder irrigation projects have been designed without taking women into consideration Policy should be changed to allow women to be allocated irrigation plots This would enable them to play a leading role in the management of the schemes to ensure that food security problems are dealt with

Literature Cited

CSO (Central Statistical Office) 1992 *Population census Preliminary results* Harare Zimbabwe

Horming H M 1987 Keynote address In *Technical papers from the expert consultation on irrigation water charges* Vol 2 Rome FAO/USAID

Jayne T S M Chisvo S Chigume and C Chopak 1990 Grain market reliability access and growth in low potential areas of Zimbabwe Implications for national and regional supply coordination in the SADCC region In *Food security policies in the SADCC region* ed Mandivamba Rukuni Godfrey Mudimu and Thomas S Jayne Proceedings of the Fifth Annual Conference on Food Security Research in Southern Africa Harare University of Zimbabwe

Moris Thom and R Norman 1984 Prospects for small scale irrigation development in the Sahel pages 3 Water Management Synthesis II Report 26 Logan Utah Utah State University Department of Agricultural Engineering

Morris Jon 1987 Irrigation as a privileged solution in African development *Development Policy Review* 5 99 123

Repetto Robert 1986 Performance problems in public irrigation systems In *Skimming the water Rent seeking and the performance of public irrigation systems* Research Report No 4 Washington D C World Resources Institute

Reutlinger Shlomo 1987 Food security and poverty in developing countries In *Food policy Integrating supply distribution and consumption* ed J Price Gittinger Jopane Leslie and Caroline Hoisington 205 14 Baltimore Johns Hopkins University Press

Roder Wolf 1965 *The Sabi Valley irrigation projects* Department of Geography Research Paper No 99 Chicago University of Chicago

Rukuni Mandivamba 1984 Organization and management of smallholder irrigation The case of Zimbabwe *Journal of Agricultural Administration (Special issue on irrigation and water management)* 17 4

Rukuni Mandivamba 1990 Introduction Zimbabwe food insecurity paradox In *Integrating food nutrition and agricultural policy in Zimbabwe* Proceedings of the First National Consultative Workshop Juliasdale University of Zimbabwe

Small Leslie and Ian Carruthers 1990 *Financing irrigation investment* Cambridge Cambridge University Press

USAID 1987 The case for African irrigation development In *Africa irrigation overview main report* Water Management Synthesis II Report 37 Logan Utah Utah State University Department of Agricultural Engineering

Summaries / Résumés

French Summaries of English Papers and English Summaries of French Papers

TRANSFORMATION AND EMERGENCE OF A RURAL SECTOR OF SMALL AND MEDIUM FOOD-PROCESSING ENTERPRISES

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Despite the problems of the food producing sector of Benin in recent years food processing considered an informal and marginalized market, has demonstrated dynamism and a capacity to adapt to the socio-economic changes overtaking the country The increased activity is most notable in the production of gari (cassava meal) The present study examines the function of micro-enterprises, as well as their performance

The study was carried out in three sub-prefectures of the Department of Oueme where the production and processing of manioc is important Twenty-eight enterprises (of which 25 were individual and 3 were collectives) were covered by the inquiry In addition interviews were conducted with operators of branch factories with merchants and with local artisans who manufacture small tools and equipment

Nearly 90% of the women in the area are committed to producing gari They produce some of their own raw materials, but the degree of vertical integration and other characteristics of age length of time of the activity and the amount of instruction received have little influence on the results obtained Instead the level of production and the realized revenues by the enterprises depend on production capacity and ease of access to capital In other words the enterprises that have access to revolving funds and that have adequate storage capacity obtain the best results

In general the performance of the enterprises depends on strong internal organization access to capital a favorable environment and the goals of the heads of the enterprises Thus the individual enterprises seem to perform better than the collectives Their adjustment to the dynamics of innovation is shown by the adoption of improved technologies (tools and equipment) and by social reorganization for the production of gari Nonetheless only 25% of the enterprises functioned under optimum conditions for net gains and returns on investment This is why the emergence of an effective sector of small and medium enterprises requires that constraints be lifted by creating a technologically and socio economically favorable environment particularly an appropriate credit policy

IRRIGATION DANS LE BLOC TULI AU BOTSWANA TECHNIQUES DE CONSERVATION DE L'EAU OU STRATEGIES OPTIMALES?

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La production de l agriculture pluviale constitue un probleme majeur au Botswana comme dans d autres pays semi-arides Cependant et pour de multiples raisons le Botswana utilise peu l irrigation Il n'y a pas beaucoup de rivieres perennes pour soutenir des grands amenagements d irrigation Jusqu'au moment ou la presente etude a ete faite le niveau des

connaissances des agriculteurs locaux sur la pratique de l'irrigation n'etait pas connu, de même que la maniere dont ils perçoivent les avantages des diverses techniques appliquees Si l on met a part le fait qu aucune recherche n'a ete faite au Botswana dans le passe sur l'irrigation, le pays n a aucune politique en la matiere

La presente etude constitue la premiere tentative de recherche sur les activites d irrigation au Botswana, en utilisant le Bloc Tuli comme une etude de cas L etude avait pour objectifs premierement, identifier les differentes techniques d'irrigation utilisees par les agriculteurs qui la pratiquent a une echelle commerciale et deuxiemement examiner les raisons pour lesquelles les agriculteurs choisissent telle ou telle autre technique d irrigation

La recherche a etabli que les techniques d'irrigation utilisees dans le Bloc Tuli sont la submersion (a partir de canaux), les asperseurs, les microjets, le goutte a goutte et le pivot La majorite des agriculteurs locaux pratiquent l'irrigation par submersion, alors que les nouveaux colons utilisent les autres methodes La raison donnee par les agriculteurs locaux pour la pratique de l'irrigation par submersion est que son installation et son entretien sont bon marches et que son fonctionnement est simple Cependant, cette technique gaspille trop d eau et pourrait bien, a long terme, être plus coûteuse que ses utilisateurs ne le pensent Les colons preferent les microjets et le goutte a goutte parce qu'elles sont plus fiables

On recommande que l etat accepte de subventionner les technologies qui conservent l eau et le sol afin d'en encourager une utilisation plus etendue

UTILISATION DE LA MAIN D'OEUVRE EN AGRICULTURE PAYSANNE FERMES PRIVÉES ET COOPÉRATIVES DANS UN VILLAGE ÉTHIOPIEN

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La plupart des efforts de developpement faits en Ethiopie partait du principe que le pays avait un surplus de main d oeuvre, mais sans que ceci ait ete prouve Le present article examine le concept de surplus de main d'oeuvre dans le cadre d un village ethiopien Une enquête a ete menee dans le village de Oudie, qui couvrait 195 foyers en vue d'obtenir des donnees sur la main d'oeuvre disponible Sur ces total, 125 foyers etaient des fermes privees et 70 provenaient d'une ferme collective L'enquête generale a ete suivie d'une etude approfondie de la repartition du temps dans 12 foyers, etude qui a dure une semaine, pendant la saison de pointe et pendant la saison creuse

Certains chercheurs ont defini la main d oeuvre en surplus comme etant la main d'oeuvre disponible pour la production agricole moins la main d'oeuvre necessaire a la production agricole Cependant, la presente etude pense que le surplus de main d oeuvre devrait plutôt être defini comme la main d oeuvre disponible pour toutes les activites requises moins celle necessaire a ces activites En plus de la production agricole, les activites d'entretien du foyer et les engagements sociaux sont toutes necessaires pour garantir un fonctionnement efficace du foyer et de la communaute

Trois versions d un même modele ont ete mis au point pour determiner le niveau de main d oeuvre en surplus Dans deux de ces versions, la main d oeuvre disponible pour les occupations agricoles avait une definition etroite de laquelle on avait exclus une partie substantielle du travail des femmes et des enfants, specialement reservee aux soins donnes

aux animaux Une distinction a ete faite entre quatre types de main d'oeuvre la main d oeuvre familiale salariee, communautaire et collective

Selon les hypotheses qui sont a la base du modele utilise les resultats statistiques suggerent l existence d une main d oeuvre residuelle dans le travail necessaire aux travaux agricoles La proportion de main d oeuvre residuelle variait entre 78% de la main d'oeuvre disponible dans les fermes privees (sans ajustement pour les autres activites des femmes et des enfants) et 55% seulement pour les fermes cooperatives apres avoir fait les ajustements necessaires pour exclure la main d'oeuvre allouee aux soins donnes aux animaux

Cependant l etude de la repartition du temps indiquait que les gens utilisent la plus grande partie de leur temps a des activites necessaires Le temps consacre aux activites autres que le travail n augmentait pas de maniere significative pendant la saison creuse de l agriculture Par contre d'autres activites d'entretien du foyer telles que soigner les animaux ramasser le bois de feu chercher l eau et construire des clôtures occupaient le temps non utilise pour la production agricole

L etude de la repartition du temps a aussi revele des modeles de repartition du travail selon les sexes les femmes participaient beaucoup plus que les hommes aux activites d'entretien du foyer alors que les hommes consacraient beaucoup plus de temps a la production agricole

EFFETS DE LA LIBERALISATION DU TAUX DE CHANGE ET DE LA SUPPRESSION DES SUBVENTIONS ACCORDÉES AUX INTRANTS SUR LA COMPETITIVITE DES CÉREALES AU GHANA

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La liberalisation des taux de change et la dereglementation des marches des intrants et des produits constituent l element central du Programme d ajustement structurel mis en route par le Gouvernement du Ghana pour stimuler la croissance de l economie Le present article se penche sur les effets de la liberalisation du taux de change et la suppression des subventions accordees aux intrants, sur la productivite et la competitivite des cereales au Ghana

En utilisant des donnees primaires et secondaires sur le sous secteur des cereales, les niveaux de productivite a la ferme pour diverses technologies de production cerealiere les mesures de protection et avantages compares ainsi que les effets d un taux de change assoupli sur les prix relatifs des cereales ont ete etudies entre les annees 1986 et 1992 L etude montre que la liberalisation du taux de change et la suppression des subventions ont eu un impact substantiel sur la productivite et la competitivite des cereales au Ghana

La productivite de la terre cultivee en cereales a augmente en moyenne entre les annees 1986 et 1988 lorsque les intrants agricoles les plus importants (engrais, machines etc) beneficiaient encore de certaines subventions Cependant de 1988 a 1992 la productivite de la terre a connu un declin general, parce que les agriculteurs employaient moins d'intrants agricoles dont le coût avait augmente par suite de l application de la politique de liberalisation De même les coûts de production eleves et la diminution de la productivite qui en est resultee se sont traduits par une chute des revenus financiers par hectare en particulier pour les producteurs de mais et de riz

La protection dont beneficiaient les cereales produites au Ghana s est erodee elle-aussi Pour le riz, la protection nominale etait ramenee de 54 pour cent en 1988, a 20 pour cent en 1992 et le mais, la protection nominale qui etait de 10 pour cent en 1988, se changeait en une taxe implicite de 1 pour cent en 1992 La protection nominale du sorgho et du millet a aussi diminue passant de plus de 40 pour cent en 1988 a 4 pour cent seulement en 1992 De plus le coût eleve des intrants s'est traduit pour toutes les cereales a l'exception du riz, par un passage d'une protection positive effective (plus de 33 pour cent pour le mais mecanise et plus de 70 pour cent pour le sorgho et le millet ameliores) a une taxation en 1992 (taxe implicite de 3 pour cent sur le mais et de 6 pour cent sur le sorgho et le millet)

En termes de competitivite, l'effet de la liberalisation et de la suppression des subventions sur les intrants sur les cereales au Ghana a ete mitigee Alors que la competitivite du sorgho et du millet s est amelioree entre 1988 et 1992, tant a l exploitation qu'a la vente en gros (probablement parce que ces cultures exigent moins d'intrants importes), celle du mais et du riz a decline au niveau des prix de gros De plus, les prix relatifs des cereales indiquaient que ces politiques, qui ont tendance a proteger les cereales importables (comme le riz) ont eu un effet adverse sur la production des cereales exportables (comme le mais)

Les analyses suggerent que l'objectif du gouvernement d'augmenter la productivite des cultures de cereales pour l'auto-suffisance et la securite alimentaires a subi un echec dans le cadre de la politique de liberalisation, parce qu'elle s'est traduite par une compression des ressources pour le sous-secteur Si le gouvernement veut poursuivre son objectif politique d'accroître la productivite pour les producteurs de cereales, il sera necessaire d introduire un type de subvention selectif qui sera specifique a la fois pour les intrants et pour les cultures, et qui encourage aussi la participation du secteur prive

FACTEURS DÉTERMINANTS ET EFFICACITÉ DE LA POLITIQUE DES DÉPENSES DU GOUVERNEMENT DANS LE SECTEUR AGRICOLE DU GHANA

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A cours de ces trois dernieres decennies, le Ghana a ete gouverne par une serie de regimes ayant des ordres du jour politiques et economiques divers Tous ces regimes ont utilise les depenses publiques comme un instrument politique pour ancrer la croissance du secteur agricole du Ghana, qui constitue l'ossature de l'economie de la nation En depit de ces efforts et pendant la periode etudiee (1960-1987), la productivite agricole a generalement connu un declin, posant ainsi un certain nombre de questions sur l'histoire, les facteurs determinants et l'efficacite des depenses agricoles publiques au Ghana

L analyse des donnees pendant la periode etudiee montre que le niveau des depenses annuelles du gouvernement pour l'agriculture etait assez bas, avec une moyenne de 1,5% du produit national brut, 1 51% du produit interieur brut, et 8% des depenses totales du gouvernement En termes reels, la depense publique en agriculture atteignait son sommet en 1965 et diminuait par la suite de pres de 80% jusqu'en 1987

Depuis 1960, date a laquelle le Ghana est devenu une republique, le gouvernement ghaneen a ete largement domine par des regimes militaires, avec des gouvernements civils de 1960 a 1966, de 1969 a 1972 puis de 1979 a 1981 L'examen des depenses agricoles par type de

gouvernement montre que les depenses annuelles *reelles* pour l agriculture ont ete de 71% plus elevees dans les regimes civils Alors que ces depenses ont augmente en moyenne de 6 2% par an avec les gouvernements civils, elles ont diminue de 1,7% par an sous les gouvernements militaires Et bien que la part moyenne de l'agriculture dans le total des dépenses publiques ait ete presque equivalente pour les deux types de gouvernement, on trouve une correlation negative entre la part de la defense et celle de l'agriculture dans les depenses totales du gouvernement

En matiere de developpement economique national les gouvernements du Ghana ont suivi une approche soit socialiste soit orientee vers le marche Comme on peut s'y attendre, la comparaison des depenses du gouvernement par orientation economique pour les annees 1960 a 1986 montre que la croissance annuelle moyenne des depenses reelles du gouvernement pour l agriculture a ete plus eleve sous les regimes socialistes par rapport aux regimes orientes vers le marche, avec une moyenne de 6,3% pour les premiers et - 6 0% pour les autres De même, la part de l agriculture dans le total des depenses du gouvernement a ete legerement plus elevee sous l'administration socialiste Un des objectifs poursuivis par les reformes de politiques introduites au Ghana en avril 1983 dans le cadre du Programme d ajustement structurel appuye par la Banque mondiale, etait d etendre la part de l agriculture dans les depenses publiques totales pour la porter a un niveau egal a 18% Le fait que la part de l agriculture dans les depenses totales du gouvernement tombait de 11 39% en 1983 a 6,05% en 1986, lorsque les politiques orientees vers le marche etaient en vigueur appuie plus encore l'hypothese que les regimes orientes vers le marche ont tendance a engager moins de ressources financieres dans l agriculture

Une approche de reaction a la politique a ete suivie pour verifier les facteurs determinants des depenses agricoles du gouvernement Des tests standards de causalite economique ont ete utilises pour tester quelles ont ete les variables qui ont affecte le niveau des dépenses publiques en agriculture On a trouve que le produit interieur brut provenant de l'agriculture le revenu agricole par habitant les recettes fiscales du gouvernement, les depenses totales du gouvernement, et le rapport du revenu agricole au revenu non agricole indiquent une relation de cause a effet avec le niveau des depenses publiques en agriculture On a trouve que la croissance des depenses publiques en agriculture etait liee a la croissance de huit variables dont la production agricole totale, le revenu agricole par habitant le rapport du revenu agricole au revenu non agricole et les recettes fiscales totales du gouvernement De même on a trouve que la part de l agriculture dans le total des depenses du gouvernement etait elle aussi liee a huit variables, dont la production agricole totale le revenu agricole par habitant le rapport du revenu agricole au revenu non agricole, les prix *reels* du cafe et le type de gestion economique

Ces tests de causalite montrent que le niveau des depenses agricoles publiques est determine par les ressources financieres publiques disponibles et le besoin ressenti de realiser les objectifs suivants de la politique agricole (1) augmenter la production agricole, (2) augmenter le revenu des travailleurs en agriculture et (3) augmenter les revenus agricoles par rapport aux revenus du reste de l economie

Un parametre variable la fonction agriculture-production a ete utilisee pour estimer l efficacite des depenses *reelles* du gouvernement dans l'augmentation de la production agricole globale L'elasticite de la production agricole *reelle* par rapport a la depense publique *reelle* en agriculture a ete calculee a partir des resultats de la correlation On a trouve que pour la periode 1965 a 1987, l'elasticite moyenne de l efficacite de la politique etait de 0 2973 ce qui signifie qu'une augmentation de 10% dans la variable ponderee representant la depense en agriculture correspondait a une diminution moyenne de 2,97% dans la production agricole totale L'efficacite de la politique des depenses agricoles

semble avoir varie pendant la periode d'etude, etant la moins inefficace dans les annees 1980 et la plus inefficace dans les annees 1970

Les resultats de l etude montrent clairement que le type de gouvernement et le type de gestion economique ont entraîne une difference reelle dans le niveau et le taux de croissance des ressources financieres consacrees a l'agriculture Le resultat en est que pour liberer des ressources financieres publiques pour le developpement de l'agriculture, on a besoin de reduire les depenses publiques pour la defense et d'encourager l'election democratique d'une administration civile De plus, toute dynamique visant a une economie orientee vers le marche doit être moderee par un contrôle prudent des depenses publiques pour empêcher l agriculture de souffrir encore plus

L'elasticite estimee de l'efficacite de la politique generale indique que les politiques de depenses publiques en agriculture ont generalement ete peu efficaces pour encourager la croissance de la production agricole globale pendant la periode consideree Aussi, il importe de reviser la politique des depenses publiques en general, et la politique des depenses du gouvernement pour l'agriculture en particulier si on cherche a faire jouer a la politique des depenses publiques un rôle significatif dans le processus de developpement de l'agriculture au Ghana

LA POLITIQUE DE FIXATION DES PRIX ET DE DISTRIBUTION DES ENGRAIS AU GHANA

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Afin de satisfaire a une demande alimentaire croissante due a la croissance rapide de la population, au taux eleve de l'urbanisation et a l'une augmentation moderee du revenu par habitant, le Gouvernement du Ghana a lance son programme de developpement agricole a moyen terme Le programme visait a augmenter la croissance d'au moins 4 pour cent par an dans le secteur agricole

Mais il n'est pas possible d atteindre les objectifs fixes dans le programme sans une transformation technologique de l'agriculture du Ghana, laquelle etait traditionnellement basee sur des systemes de culture itinerante Ces systemes, dont la reussite depend de l'abondance des terres a cultiver, ne sont plus viables a cause de la pression croissante sur la terre, elle-même due a une forte augmentation de la population qui a pousse les agriculteurs a adopter des methodes de culture plus intensives

Comme le niveau de la consommation des engrais au Ghana est un des plus bas au monde, les pratiques culturales actuelles provoquent l'erosion du sol et la reduction de sa capacite de production Pour sauver l'agriculture du Ghana, il faut prendre des mesures pour augmenter la presence et la consommation des engrais dans le moyen terme Pour ce faire, la strategie du Ghana a ete de privatiser l'approvisionnement et la distribution des engrais Mais en même temps, les subventions dont beneficiaient les engrais etait supprimees ce qui a diminue la demande

En utilisant des donnees provenant de sources primaires et secondaires, la presente etude a examine certaines des causes du bas niveau d'utilisation et du faible volume de la vente des engrais au detail, apres l'application de reformes dans les prix et la distribution

Les principales cultures auxquelles les agriculteurs appliquent des engrais sont le mais et le riz Cependant, les resultats de l enquête indiquent que de nombreux agriculteurs n'utilisent pas d engrais sur leurs cultures vivrieres Et même parmi ceux qui utilisent des

engrais un grand nombre en appliquent moins que les doses recommandees Le bas niveau d'utilisation des engrais peut s expliquer par le manque de connaissances sur l efficacite et les methodes d'application et par leur prix eleve en l absence de credit

Malgre les efforts faits pour ameliorer les approvisionnements en engrais, un grand nombre d agriculteurs qui les utilisent se plaignent des difficultes qu ils ont a les obtenir

Bien que la participation du secteur prive a l'approvisionnement et a la distribution des engrais ait mene a la presence de nouvelles formes d engrais et tout specialement des produits permettant d obtenir de hauts rendements la reponse du secteur prive au plan de privatisation a ete faible

La faible participation du secteur prive au plan de privatisation peut s expliquer par un certain nombre de facteurs et en particulier, la reduction de la demande primaire a la suite de l augmentation des prix, l accumulation de stocks dans les entrepôts du Ministere de l agriculture, ce qui decourage les revendeurs, la participation continue des organisations du secteur public dans la vente des engrais au detail ce qui a tempere l enthousiasme de nombreux revendeurs prives, les faibles marges autorisees par le gouvernement, qui font que la vente des engrais au detail est moins interessante que d autre produits le manque de formation des detaillants dans la manutention du produit l absence de credit pour faire face aux besoins en capital necessaire pour acquerir quelques tonnes d engrais et enfin, au debut la politique de perequation territoriale (uniformite des prix dans tout le pays), qui decourageait les detaillants de vendre des engrais dans des localites eloignees des entrepôts

L existence d un marche des cereales defavorable a lui-aussi gêne le developpement de la commercialisation des intrants par les commerçants prives Le fait que le marche des cereales n ait pas reussi a mettre fin aux fluctuations saisonnieres des prix a mene a une politique d intervention du gouvernement sous forme d un soutien des prix du mais a la vente sur l exploitation Ce systeme n a pas reussi a fournir les incitations necessaires aux producteurs a cause de son mauvais fonctionnement Le gouvernement ne pouvait pas agir comme acheteur de dernier ressort parce que sa capacite d'intervention ne couvrait que 6 pour cent du marche par suite de problemes logistiques et financiers

L'INTEGRATION DU MARCHÉ LE CAS DES LEGUMES DE SAISON SÈCHE AU NIGERIA

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La production des legumes a non seulement ameliore la qualite nutritionnelle de l alimentation des habitants du Nigeria, mais encore la culture irriguee et la commercialisation des legumes offrent des emplois a de nombreuses personnes pendant la saison seche Cependant comme les legumes sont des denrees hautement perissables les risques de la vente sont substantiels et le manque d efficacite du marche coûte cher Les prix eleves qui prevalent dans les zones urbaines et les bas prix payes a l agriculteur sont le resultat de mauvaises infrastructures de mauvais services de commercialisation ainsi que d une etude insuffisante de la politique de commercialisation

L etude visait a obtenir des indices de l inefficacite de la commercialisation dans la zone d etude par l approche de l integration du marche et de proposer des solutions Les donnees hebdomadaires sur les prix du piment *(tatashe)* et des tomates ont ete recueillies dans huit lieux quatre zones de production deux zones de production et de consommation

et deux zones de consommation - pendant 34 semaines (de novembre 1991 a juin 1992) et un modele de type Ravaillon a eté utilise pour analyser l'integration du marche entre la production et la consommation

Les resultats indiquent qu il y avait peu d'integration des marches du piment et de la tomate dans la zone d'etude en general Il existe cependant une certaine integration entre les principales zones de production et les principales zones de consommation Les resultats indiquent aussi que de bonnes routes de desserte sont importantes pour que les marches soient integres, mais que la distance entre les marches l'est moins De même, le probleme des reseaux existe aussi, et les decisions pour la commercialisation des legumes sont affectees de façon significative par les facteurs sociaux, politiques et economiques a l echelle locale

La conclusion est que le flux d'information entre les zones de production et de consommation constitue un element determinant pour l'integration du marche dans la zone d'etude (et sans doute dans l'ensemble du Nigeria), a l'heure actuelle, les ramasseurs des produits, principalement les grossistes et les transporteurs sont les principales sources d information Il est clair que cette situation n'est pas satisfaisante si on veut une commercialisation efficace des produits Le Gouvernement federal ou les gouvernements des etats devront accorder la priorite a la collecte et a la diffusion journaliere ou hebdomadaire de l'information, et tout specialement celle des prix, pour ameliorer l efficacite de la commercialisation et par suite de la production des cultures vivrieres en general et des legumes de saison seche en particulier Parmi d'autres sujets de politique a poursuivre l elimination des grossistes secondaires dans la chaîne de la commercialisation et l'etablissement d un systeme d assurance pour les revendeurs de legumes, la promotion d'une transformation a petite echelle des legumes et la mise sur pied de services de vulgarisation efficaces pour les producteurs et les revendeurs de legumes de saison seche

PRESSION DE LA POPULATION, UTILISATION DES TERRES ET PRODUCTIVITÉ DES SYSTÈMES AGRICOLES DANS LA SAVANE OUEST-AFRICAINE

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Le probleme de la degradation des ressources avec l'evolution des systemes d'exploitation attire une attention croissante de la recherche agro-economique La limite des terres ayant ete atteinte dans de nombreux pays de l'Afrique sub-saharienne, l'augmentation de la production agricole devra venir de l'intensification de l'exploitation de la terre et des autres ressources agricoles Avec cette intensification de l'exploitation de la terre, les periodes de jacheres diminuent et la production agricole atteint des terres marginales ou ecologiquement fragiles En l'absence de technologies appropriees de gestion des ressources, ces pratiques conduisent inevitablement a la degradation de la base des ressources avec tout ce que cela implique pour la productivite du sol, la securite alimentaire des familles et la pauvrete dans les zones rurales

Bien que les agro-economistes aient tente de conceptualiser ces relations biophysiques et socio-economiques et d identifier les causes et consequences possibles du processus d intensification, peu de tentatives ont ete faites pour quantifier ces relations La presente etude tente de rectifier ce desequilibre en proposant un modele quantitatif du processus

d intensification en utilisant des donnees d enquêtes provenant de la savane nord guineenne de l Afrique de l ouest

La these presentee par l etude est que la gravite du probleme pose par l'intensification de l agriculture et de la degradation de l environnement qui en resulte depend dans une large mesure des facteurs qui poussent le systeme a s intensifier Cet argument repose sur l hypothese selon laquelle les deux forces motrices principales du processus d intensification, l augmentation de la densite de la population et un meilleur acces au marche aboutissent a des systemes d'exploitation agricole ayant une base de ressources des pratiques culturales et des contraintes differentes

L etude considere le role des facteurs economiques pour expliquer les investissements qui encouragent la productivite (par exemple l'application des engrais) et ameliorent la viabilite L etude utilise la programmation lineaire pour creer des plans d exploitation optimaux dans lesquels les schemas de culture le niveau de l'utilisation des ressources et la valeur actuelle du revenu net de l'exploitation sont determines de façon endogene Le modele simule la trajectoire de divers types d intensification agricole lorsque les conditions initiales changent a cause d'interventions demographiques, technologiques et politiques exogenes La conclusion de cela est qu il existe des differences substantielles dans le bien-être de l agriculteur les schemas d exploitation et la productivite des ressources entre une intensification poussee par l'augmentation de la population et l intensification poussee par le marche

LE RÉGIME FONCIER ET L'EXPLOITATION DES RESSOURCES DES FORÊTS DE PALMIERS AU NIGÉRIA

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Le Nigeria est dote de riches forêts de palmiers qui ont une importance economique considerable pour un certain nombre de communautes dont le gagne-pain depend des ressources forestieres Cependant on note en plusieurs lieux une pression de plus en plus forte sur les forêts de palmiers par suite d une croissance de la commercialisation La presente etude a examine les pratiques de gestion traditionnelles et la rentabilite des entreprises de production associees

Les forêts de palmiers sont exploitees pour deux raisons essentielles Les fruits des palmiers a huile sont recoltes pour l'extraction de l'huile de palme et les palmiers a raphia peuvent être saignes pour obtenir le vin de palme que l on peut transformer en une eau-de vie locale connue sous le nom d *Ogogoro* En 1991 dans l etat de Ondo ou l etude a ete mence les producteurs d huile de palme ont produit une moyenne de 2 931 litres d huile de palme a partir de 4 530 regimes recoltes De même dans les zones d Ilaje et d Apoi dans le même etat, ou les saigneurs ont produit des moyennes de 29 835 et 24 980 litres de vin de palme pres de 2 242 et 2 027 litres d eau-de-vie locale ont ete produits respectivement En fait ces entreprises se sont averees rentables Les benefices dans la production de l huile de palme excedaient ceux du vin de palme d'un montant de 1 293 Naira (soit 15%) et le revenu net etait superieur de 2 285 N (soit 36%)

L exploitation des ressources des forêts de palmiers se trouve largement entre les mains de migrants qui acquierent des licences d exploitation en payant des droits d acces et de location En 1991 le droit d acces pour la recolte de l huile de palme etait de 40 N et la location de 150 N par an Dans la ceinture du palmier a raphia le droit d acces etait de 10 N et la location en moyenne de 237 N Ces tarifs semblent moderes et ne sont pas soumises

a des modifications frequentes Ceci a constitue un type d'incitation pour encourager les exploitants des ressources a poursuivre ce genre d'occupation

Vu l'importance des forêts de palmiers comme source de revenus et les difficultes eprouvees dans certaines regions, certaines communautes ont adopte des pratiques de gestion visant a reglementer le comportement des exploitants et eviter la sur-exploitation Ces pratiques comprennent l'interdiction d'abattre les palmiers a raphia, l'interdiction de saigner des palmiers avant leur maturite, une saison de fermeture des plantations de palmiers a huile et une limitation du nombre de regimes recoltes par jour Grâce au regime prevalent de la propriete commune et a la rentabilite des entreprises, il n a pas ete difficile de faire respecter les regles de la gestion Parmi les autres facteurs qui ont une influence favorable sur l adoption de ces pratiques de gestion, on note le systeme de croyances commun des locataires recolteurs, les relations sociales serrees et l'homogeneite culturelle et linguistique

Lorsque des conflits ont surgi concernant l'exploitation et la propriete des forêts de palmiers il a ete possible de les resoudre par la negociation, la mediation et l arbitrage plutôt que par la voie judiciaire Les procedures non-judiciaires ont la preference parce qu elles sont rapides, d un coût modeste, faciles a acceder et qu'elles encouragent la tendance a la reconciliation

Par consequent et comme certains analystes l'ont fortement recommande, l intervention du gouvernement dans l'acces et la gestion des forêts de palmiers ne semble pas justifiee dans la zone d etude Puisqu un mecanisme souple de regulation existe deja, le rôle du gouvernement est d examiner les caracteristiques des institutions locales pour determiner la façon de les renforcer et les rendre plus officielles, et encourager leur adoption dans d autres zones de forêts de palmiers dans le pays Dans toutes les zones economiques concernees, le gouvernement devra renforcer les systemes de gestion existant sur place a savoir (i) aider a definir des limites territoriales qui a l heure actuelle n existent pas ou sont contestees, (ii) reconnaître et renforcer les autorites traditionnelles qui sont impliquees dans la gestion des ressources des forêts de palmiers, (iii) conscientiser la communaute pour l amener a participer a la gestion des ressources des forêts de palmiers et (iv) fournir les conseils techniques aux communautes desireuses d intensifier la gestion

ECONOMIE DE L'IRRIGATION DANS LA PRODUCTION AGRICOLE AU NIGÉRIA

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Les efforts du Nigeria pour reduire la contrainte de l eau comme intrant de la production agricole ont ete domines par des investissements enormes dans des systemes d irrigation a grande echelle qui, dans la plupart des cas, se sont reveles être des echecs tant techniques qu economiques Aussi, ceci a conduit, au cours de ces dernieres annees a un changement de la politique du gouvernement, pour passer des projets d'irrigation a grande echelle a des projets a moyenne et petite echelle

La presente etude a ete conçue pour estimer quelle etait la contribution economique de l irrigation a petite echelle (moto-pompes) a la production agricole du Nigeria en utilisant des donnees de gestion d'exploitations agricoles de 1991, dans un echantillon de 100 exploitations irriguees et de 110 exploitations non irriguees, dans l etat de Kaduna

L'analyse des fonctions de production a montre que le changement technique apporte par les petits systemes d irrigation est influence par ce facteur et que l efficience technique est plus elevee dans les exploitations irriguees que dans celles qui ne sont pas Dans les deux types d exploitations on a trouve que l allocation de toutes les ressources de production couvertes par l etude etait inefficace Cependant en terme relatifs les exploitations irriguees etaient plus efficaces dans l allocation des terres

L etude a aussi montre que les exploitations non irriguees sous utilisaient la terre, le capital et autres intrants agricoles pour lesquels les coefficients de regression estimes etaient statistiquement significatifs Les exploitations irriguees sous-utilisaient aussi la terre le capital et les autres intrants agricoles tout en sur-utilisant la main d oeuvre et les services d'irrigation

L analyse budgetaire a montre que les exploitations irriguees utilisaient de plus grandes quantites d intrants variables que les exploitations non irriguees De plus, elle a montre que la production par unite etait bien plus elevee dans les exploitations irriguees que dans les exploitations non irriguees et que les exploitations irriguees obtenaient ce surplus de production en utilisant de plus grandes quantites d intrants avec des coûts de production unitaires relativement plus eleves Cependant la marge beneficiaire par unite restait plus elevee dans les exploitations irriguees

Les niveaux plus eleves de l efficacite technique et des marges beneficiaires semblent appuyer les efforts actuels du gouvernement et les investissements enormes faits dans l infrastructure de l irrigation comme moyen d augmenter la productivite agricole et le revenu au Nigeria En vue d exploiter tout le potentiel offert par l'irrigation les agriculteurs devront recevoir un paquet complet comprenant les intrants pour la production un meilleur acces a la terre le remembrement des terres par la creation de cooperatives de production un entretien regulier des systemes d irrigation pour eviter les pannes frequentes des moto pompes ainsi que des programmes de formation sur le fonctionnement l entretien et les reparations des installations d irrigation

Pour obtenir une allocation optimale des ressources les exploitations non irriguees doivent utiliser plus de terre de capital et autres intrants agricoles pour lesquels les coefficients de regression etaient statistiquement significatifs De même les exploitations irriguees doivent augmenter l utilisation de la terre du capital et des autres intrants agricoles tout en reduisant l'utilisation de la main d'oeuvre et des services d irrigation

RECOUVREMENT DES FRAIS, PARTICIPATION ET MANQUE D'EFFICACITE DANS LES PERIMETRES IRRIGUES DU SOUDAN

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L agriculture irriguee constitue l epine dorsale de l'economie du Soudan La reussite ou l echec de l agriculture irriguee a ete attribuee en premier lieu a la politique des relations de production Les relations de production etaient regies par le systeme des comptes joints jusqu en 1980/1981 lorsqu a la suite de defauts graves dans ce systeme une politique alternative etait adoptee connue sous le nom de systeme de comptes individuels

L element decisif dans l adoption du systeme des comptes individuels etait la recherche d un moyen de faire payer pour l eau ce systeme avait l appui de la Banque mondiale,

entre autres et etait encourage pour des raisons economiques et financieres, en particulier le remboursement des depenses, la prise de participation, l'efficience economique et l amelioration de la situation financiere Au Soudan, le capital et les depenses courantes pour l eau d'irrigation sont plus elevees que le prix de tout autre intrant Donc dans la planification et le fonctionnement des perimetres d'irrigation, il faut reconnaître toute l importance de la mise en place d un systeme permettant de faire payer les beneficiaires

Dans la presente etude, notre approche a la politique qui consiste a faire payer pour la terre et l'eau partait d'un point de vue purement financier, a savoir le remboursement des depenses l'efficience economique et une prise de participation Des donnees financieres secondaires etaient recueillies dans les registres des perimetres de Gezira et de Rahad et du Ministere de l irrigation pour la periode ecoulee entre les annees 1981/1982 et 1990/1991 Les donnees quantitatives etaient completees par des donnees qualitatives obtenues en interrogeant des cadres superieurs occupant des postes cles dans ces organisations On a trouve que les perimetres d irrigation sont loin d atteindre le plein recouvrement des depenses Le taux de recouvrement moyen pour Gezira et Rahad sont de 52 et 60 pour cent respectivement Il s est aussi avere que les allocations des coûts entre les cultures etaient faussees et que certaines cultures n'etaient pas traitees equitablement De plus le manque d'efficacite de l administration dans la fixation des tarifs de l eau, le contrôle des coûts la preparation des budgets et la collecte des redevances des usagers a eu des consequences graves pour le recouvrement des depenses et les prises de participation

En se basant sur ces observations, plusieurs interventions politiques sont proposees Premierement le niveau du remboursement des depenses doit être base sur les depenses reelles et non les depenses echues Ceci parce l experience a montre que les depenses reelles ont toujours largement depasse les depenses echues Deuxiemement, les principaux facteurs qui conduisent a un meilleur remboursement sont le contrôle des cultures et de leur rentabilite par le gouvernement Cependant, le contrôle des cultures ne doit pas être encourage dans le seul but d elever le taux des remboursements parce finalement cela aura un effet nefaste sur le developpement de l'agriculture L amelioration de la rentabilite des cultures semble être une strategie meilleure pour encourager le remboursement des depenses Troisiemement, l'opinion officielle selon laquelle toutes les depenses non remboursees representent les dettes des fermiers, n'est pas justifiee En fait sur les quatre facteurs responsables du non remboursement des frais, trois sont plus les symptômes du manque d efficacite dans la gestion des perimetres irrigues et au sein du Ministere de l irrigation, que le refus ou le manque de moyens des agriculteurs pour payer

EFFET DES INTERVENTIONS DU GOUVERNEMENT SUR LE MARCHÉ AGRICOLE EN TANZANIE

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L economie de la Tanzanie repose sur l'agriculture Depuis l independance, le gouvernement tanzanien a etendu son influence sur les prix des produits, tant a la production qu a la consommation, par des interventions sur le marche La presente etude a examine les effets des interventions sur les prix agricoles et la commercialisation, sur l'allocation des ressources en Tanzanie, laquelle influe a son tour sur le niveau et l efficacite de la production agricole

Jusqu en avril 1986 le gouvernement tanzanien a maintenu un taux de change relativement fixe qui surevaluait le shilling tanzanien Apres cette periode le gouvernement a introduit des ajustements reguliers au taux de change Les devaluations ont fait pencher la politique gouvernementale en faveur de l agriculture La taxe implicite sur l agriculture qui resultait de la surevaluation etait supprimee ce qui permettait a l agriculture de devenir relativement plus rentable Cependant devaluer la monnaie augmentait le coût des intrants importes

Le systeme de commercialisation des produits agricoles a ete change maintes fois depuis l independance Les offices de commercialisation et les autorites avaient ete creees a l origine pour s occuper du commerce interregional et international Cependant ces organismes para-etatiques ont toujours ete en deficit En effet elles devaient acheter les produits aux producteurs et les vendre aux consommateurs a des prix fixes par le gouvernement L inefficacite et la mauvaise gestion n ont fait que compliquer le probleme des politiques appliquees En 1984 le gouvernement commençait a admettre le commerce libre et a reduire le rôle des etablissements para etatiques

Plusieurs strategies de fixation de prix ont ete tentees y compris des essais de prix uniformes sur l ensemble du territoire ou des prix regionaux Les prix a la production agricole ont diminue en termes reels depuis le milieu des annees 1970 et jusqu en 1982/1983 L uniformisation des prix sur l ensemble du territoire a entraîne une augmentation de la production loin des centres de consommation, mais cependant, il n existe aucune correlation entre les prix officiels et les niveaux de la production Parfois, lorsque les prix officiels etaient bas la production augmentait pour satisfaire la demande sur le marche parallele

Les niveaux de production du cafe et du coton ont subi l influence de facteurs autres que les prix comme les facteurs climatiques et une capacite de transformation inadequate Dans les regions dans lesquelles le mais est en concurrence avec le coton pour les ressources c est le prix de vente de la culture qui determine laquelle sera cultivee

Le marche libre devrait être encourage la Tanzanie progresse dans cette direction Cependant le gouvernement devrait continuer a jouer un rôle en fournissant une infrastructure et en maintenant une reserve alimentaire strategique

L'ASSISTANCE ETRANGÈRE ET LA RECHERCHE ET LE DEVELOPPEMENT AGRICOLES EN TANZANIE QUELQUES QUESTIONS POLITIQUES

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La presente etude examine l experience de la Tanzanie dans l administration des ressources de la cooperation technique Quatre institutions d enseignement et de recherche agricole financees par des bailleurs de fonds ont ete etudiees les pêcheries Mbegani, le Centre agricole Uyole la Faculte de sylviculture et la Faculte de medecine veterinaire, toutes deux de l Universite de Sokoine Pour les besoins de cette etude la cooperation technique est consideree comme un instrument majeur dans la cooperation du developpement international qui vise a elever les capacites humaines et institutionnelles par le transfert et l utilisation des connaissances, des aptitudes et de la technologie

Trois enseignements principaux peuvent être tires de l etude Premierement, l'aide etrangere, comme la plupart des autres aspects des relations internationales, etait largement gouvernee par la façon dont le pouvoir etait structure dans le systeme global On affirme que les inegalites economiques et les desequilibres entre les pouvoirs inherents au regime de l'aide internationale a invariablement une influence sur les acteurs des deux côtes du processus de l'assistance Deuxiemement, la nature de l etat, sa capacite institutionnelle et le type de strategie de developpement qu'il applique determinent pour une grande part la quantite et bien sûr la qualite de ses transactions internationales Troisiemement et comme consequence des arguments qui precedent, on voit que des politiques moins efficaces et des instruments politiques faibles pouvaient plus vraisemblablement entraîner la dislocation de l aide pour les pays beneficiaires En fait des etats beneficiaires faibles peuvent même s'affaiblir plus encore par suite d une assistance surchargee

L etude prouve que la Tanzanie n'a pas toujours reussi a exploiter au maximum la cooperation technique pour realiser les objectifs de developpement declares La principale explication de la mauvaise performance de la Tanzanie etait l incapacite de l etat a elaborer des politiques de developpement globales et etablir des cadres institutionnels efficaces et economiques pour la gestion des politiques Il en est resulte que la cooperation technique etait non seulement offerte au coup par coup et avec un certain laissez-faire mais permettait aussi aux bailleurs de fonds d'imposer leurs propres preferences a l economie Aussi dans ces circonstances peu propices, les flux de ressources etrangeres vaguement coordonnes n'ont mene ni au developpement d'une capacite institutionnelle viable, ni a des transferts de technologie cumulatifs

Une autre explication qui s impose aussi decoule directement de la premiere Les politiques de developpement de l'aide en Tanzanie etaient exceptionnellement silencieuses sur la façon de faire l'estimation des besoins en matiere de cooperation technique Le bas niveau de la cooperation technique en Tanzanie est largement attribue a cette planification et gestion economique imprudentes Trop souvent, les projets appuyes par l assistance etaient confies a la gestion et au contrôle du bailleur de fond, ils etaient rarement incorpores de maniere systematique dans les budgets annuels de developpement Aussi il n'est pas surprenant que lorsqu'il etait temps de transferer ces projets a des institutions nationales le Ministere du Tresor etait pris par surprise Par consequent des projets tels que les pêcheries de Mbegani et le centre agricole Uyole ont ete abandonnes lorsque les bailleurs de fonds cessaient de les assister

On recommande donc que les futures politiques de developpement de la Tanzanie s efforcent d'articuler sans ambiguite le rôle de l'assistance etrangere en general et celui de la cooperation technique en particulier dans l'effort de developpement national Ces politiques devront aussi mettre en place des dispositions institutionnelles capables et efficaces pour gerer les programmes nationaux de developpement Au même moment, ces institutions doivent être capables de fournir une force fiable et viable pour contrebalancer le pouvoir ecrasant des pourvoyeurs d'assistance

DEVELOPPEMENT DE L'IRRIGATION AUPRES DES PETITS EXPLOITANTS IMPACT SUR LA PRODUCTIVITE, LA PRODUCTION ALIMENTAIRE,LE REVENU ET L'EMPLOI

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L'irrigation des petites exploitations reste encore un facteur peu important dans la performance de l'agriculture du Zimbabwe, mais elle possede le potentiel d'elever la contribution globale de l'agriculture parce qu'elle est moins coûteuse que l'irrigation a grande echelle qui domine en ce moment

Au Zimbabwe, le manque d'information sur le developpement de l'irrigation aupres des petits exploitants a eu un effet adverse sur la politique la conception et la planification de l'irrigation et a contribue au manque de comprehension du sous-secteur de l'irrigation sur les petites exploitations

La presente etude a suivi une approche de recherche comparee pour analyser la performance des systemes irrigues et non irrigues, afin de mettre plus en relief l'importance de l'irrigation dans les petites exploitations

L'enquête a recueilli des donnees dans 40 foyers sur huit perimetres irrigues et 40 foyers d'exploitants sans irrigation dans les zones communales avoisinantes L'information recueillie aupres de chaque participant couvrait les cultures et la production, le coût des intrants le cheptel vif le revenu les rapatriements de salaires l'emploi la situation alimentaire le travail et la condition feminine Des donnees tant quantitatives que qualitatives ont ete recueillies en utilisant a la fois un questionnaire et une conversation informelle

L'etude a montre que les conditions agronomiques et en particulier la pluie et les disponibilites en eau determinaient la mesure dans laquelle une culture etait cultivee comme culture de rapport L'etude a observe qu'il y avait peu de differences dans les types de cultures de rapport cultivees par les petits exploitants n'utilisant pas l'irrigation Cependant l'irrigation permettait aux petits exploitants qui la pratiquent de faire deux cultures par an et de diversifier les cultures de rapport et s'adonner aux cultures horticoles de haute valeur

Dans les deux systemes avec irrigation et dans les aires communales en culture seche les petits exploitants utilisaient peu d'engrais, a cause d'un credit inadequat et pour la même raison 60% d'entre eux utilisaient leurs propres semences

Alors que 58 pour cent de la superficie totale des perimetres irrigues et non irrigues etait cultivee en mais les agriculteurs pratiquant l'irrigation avaient tendance a cultiver toutes leurs cultures vivrieres sur des terres sèches de ces perimetres Par contre, les agriculteurs ne pratiquant pas l'irrigation semaient des cultures vivrieres plus diversifiees Dans les deux cas, c'etait surtout les femmes qui s'adonnaient aux cultures vivrieres

Les donnees recueillies montraient que les exploitations qui pratiquaient l'irrigation avaient un pourcentage plus eleve de nourriture venant de sources exterieures Les foyers pratiquant l'irrigation avaient tendance a maximaliser les revenus provenant de leurs parcelles irriguees Par contraste les foyers ne pratiquant pas l'irrigation visaient a minimiser leurs achats d'aliments a cause des faibles revenus tires de leurs cultures Les foyers ne pratiquant pas l'irrigation obtenaient la plus grande partie de leur nourriture du secours a la secheresse et des transferts de salaires Les foyers ne pratiquant pas

l'irrigation avaient un plus grand nombre de parents ayant des emplois formels dans les zones urbaines qui pouvaient transferer de la nourriture ou de l'argent pour en acheter

Les foyers pratiquant l'irrigation avaient des familles plus nombreuses, et une des raisons etait le besoin d'avoir une main d'oeuvre familiale suffisante pour travailler dans les parcelles irriguees Le resultat en est qu'ils produisaient moins de nourriture par personne que les foyers ne pratiquant pas l'irrigation Aussi, la politique de developpement de l'irrigation doit se pencher sur la question de la securite alimentaire, tout en accordant la priorite aux mesures permettant d'avoir des produits alimentaires disponibles dans les perimetres irrigues parce que les exploitants qui pratiquent l'irrigation ont un pouvoir d'achat plus eleve et sont donc en meilleure posture pour acheter leur nourriture

Pour les deux types de foyers, ceux qui pratiquent et ceux qui ne pratiquent pas l'irrigation, le revenu venant des cultures etait dominant Bien que les agriculteurs pratiquant l'irrigation tiraient des revenus plus eleves de cultures de haute valeur, leurs depenses pour les intrants etaient aussi plus elevees Les agriculteurs ne pratiquant pas l'irrigation avaient une part plus elevee de leur revenu qui provenait de sources non agricoles, notamment des transferts de salaires D'une façon generale, le revenu par personne etait plus eleve dans les foyers pratiquant l'irrigation, et ceci, bien que leurs coûts de production etaient plus eleves que ceux des foyers ne la pratiquant pas

Les agriculteurs pratiquant l'irrigation employaient plus de main d'oeuvre familiale et salariee provenant essentiellement de foyers ne pratiquant pas l'irrigation Ceci souligne l'importance des perimetres d'irrigation de petits exploitants pour l'emploi La plus grande partie de l'emploi est creee en hiver a l'epoque ou les foyers ne pratiquant pas l'irrigation ne sont pas occupes et connaissent un ralentissement de la demande pour leur travail

L'etude a montre que les foyers pratiquant l'irrigation avaient moins de femmes chef d'exploitation, et la politique du gouvernement sur l'allocation des permis d'irrigation est en faveur des hommes en est une des raisons Par contre, il y a plus de femmes chef de famille parmi les agriculteurs ne pratiquant pas l'irrigation En general, les femmes des foyers ne pratiquant pas l'irrigation pouvaient acceder a des parcelles speciales sur lesquelles elles cultivaient des produits vivriers Ceci suggere que les projets d'irrigation n'ont pas ameliore la condition de la femme parce qu'elles ont moins acces a la terre et que leur rôle dans la prise des decisions au sein des foyers reste insignifiant