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Integrated Assessment of the Impact of Trade Liberalization

A Country Study on the Nigerian Rice Sector

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Foreword

Since the mid 1970's Nigeria's domestic rice production has increased at a rate of almost 10 per cent per annum, mostly as a result of extensification. But still production is unable to satisfy the constantly growing domestic demand for rice and imports have increased more than three-fold, from 300'000 tons in 1995 to about 1 million tons in 2001.

The level of rice imports for a country with such abundant agro-ecological and other natural resources suitable for rice growing is worrisome, especially as rice is gaining such importance in the average Nigerian diet. Nigeria has rich agricultural, natural and human resources, but its major weakness is in mobilizing these resources to diversify its economic base, achieve self-sufficiency and food security, and reduce poverty. Thus, since the 1970's, petroleum has accounted for around 90 per cent of Nigerian exports, leaving Nigeria at risk in terms of the fluctuating world prices of the one commodity that generates the bulk of its foreign exchange.

Over the past couple of decades or so, Nigeria has implemented a number of fiscal, monetary, wages and trade policies and reforms with the objective of redressing the economy. However, expected gains have not materialised despite increases in agricultural outputs of 20-30 per cent per year between 1986 and 1993. Instead, domestic rice production has been experiencing heavy competition from imported rice, both in terms of quality and price.

In view of the demands that rice imports make on Nigeria's limited foreign exchange, the country aims to double its production by 2005 and become a net exporter of rice by 2007. Farmers are already favouring rice production over more traditional crops such as cocoa, rubber, groundnuts, etc., and rice production and processing has created more employment opportunities. However, rice production increases will inevitably have environmental impacts, which must be minimised through proper management. Therefore, this study includes an *ex ante* assessment of the environmental consequences and suggests sustainable options to accelerate rice production.

One of the main challenges that Nigeria faces is promoting the development of its rice sector whilst ensuring environmental sustainability and without contravening the country's commitments in international and regional trade agreements and protocols, such as the WTO AoA. This study is an integrated assessment of the economic, social and environmental impacts of trade liberalization of Nigeria's rice sector. The main end goals of the project are to improve national understanding of the implications of multilateral trade rules and trade liberalization, develop policy packages to strengthen the positive impacts and ameliorate the negative impacts of rice production on the environment, foster greater cooperation between Government agencies and with stakeholders, and strengthen Nigeria's negotiating capacity at WTO talks relating to the production and trade of primary staple foods.

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A work of this nature naturally benefits from contributions from various people and institutions and this study is no exception. It is gratifying working with highly dedicated colleagues and friends in executing the project. Every member of the team gave maximum cooperation and contributed significantly in their particular areas of expertise. Special acknowledgement must go to the Director-General of NISER who kindly consented to house the study in the institute and chair the national steering committee that supervised the study and gave it the desired direction and support. The other members of the steering committee have equally contributed significantly towards the successful completion of the entire project, for which we are enormously grateful. Their individual and collective contributions so selflessly and professionally provided to the project have been quite instrumental in arriving at this output. We also acknowledge the contributions of participants at the various meetings and consultations conducted during various stages of the project. Our friends in different ministries and departments as well as colleagues in institutions of higher learning and research institutes provided unwavering support throughout the duration of the study.

Rice farmers, processors, marketers, consumers as well as input and service providers in different parts of the country where the study surveys were conducted have remained valuable allies in the last few years as we went from one community to another to study different aspects of rice. We believe the results of this exercise will find official support and concern in such a way that the policies emanating from the study and that address important issues will be implemented.

At UNEP, the project was initiated and led by Hussein Abaza. Sophie Forster Carbonnier and Mariko Hara coordinated and provided technical and logistical support to the project. The country teams prepared the full studies as well as the summaries included in the synthesis report (*Integrated Assessment of the Impact of Trade Liberalization, UNEP Country Projects Round III, A Synthesis Report)*. Thanks are due to Jan Joost Kessler, Konrad von Moltke and Fulai Sheng for having provided critical reviews of draft reports. This appreciation is also extended to the members of the international working group on rice set up by UNEP to guide and implement the projects and provide comments. The members of this group, who attended the two international expert meetings on 19-20 February and 17-18 November 2003 in Geneva, and provided useful contributions and comments on these occasions, are: Tunji Akande, Nigerian Institute of Social and Economic Research; Claude Auroi, IUED (Institut Universitaire d'Etudes du Développement); Luisa Bernal, South Centre; Concepción Calpe, FAO; Céline Charveriat, Oxfam International; Martha Chouchena-Rojas, IUCN; Aliou Diagne, West Africa Rice Development Association; Salah El Serafy, Consultant, USA; Aimée Gonzales, WWF International; Dongmei Guo, State Environmental Protection Administration, China; Nestor Gutierrez, Federación Nacional de Arroceros, Bogota; Mark Halle, IISD; Dimitris Kiakosavvas, OECD; Panos Konandreas, FAO; Doug Koplow, Earth Track, Inc.; Hans-Jörg Lehmann, Federal Office for Agriculture, Bern; Eric Peters, European Commission; Majda Petschen, WTO; Shishir Priyadarshi, South Centre; Sarah Richardson, Maeander Enterprises Ltd., Canada; Abdoulaye Sene, Institut des Sciences de l'Environnement, Dakar; Shefali Sharma, IATP; Miho Shirotori, UNCTAD; Matius Suparmoko, Jenderal Soedirman University, Indonesia; Robert Teh, WTO; Gerard van

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United Nations Environment Programme

The United Nations Environment Programme (UNEP) is the overall coordinating environmental organisation of the United Nations system. Its mission is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing and enabling nations and people to improve their quality of life without compromising that of future generations. In accordance with its mandate, UNEP works to observe, monitor and assess the state of the global environment, improve the scientific understanding of how environmental change occurs, and in turn, how such change can be managed by action-oriented national policies and international agreements. UNEP's capacity building work thus centres on helping countries strengthen environmental management in diverse areas that include fresh-water and land resource management, the conservation and sustainable use of biodiversity, marine and coastal ecosystem management, and cleaner industrial production and eco-efficiency, among many others.

UNEP, which is headquartered in Nairobi, Kenya, marked its first 30 years of service in 2002. During this time, in partnership with a global array of collaborating organisations, UNEP has achieved major advances in the development of international environmental policy and law, environmental monitoring and assessment, and the understanding of the science of global change. This work also supports the successful development and implementation of the world's major environmental conventions. In parallel, UNEP administers several multilateral environmental agreements (MEAs) including the Vienna Convention's Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (SBC), the Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention, PIC) and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity as well as the Stockholm Convention on Persistent Organic Pollutants (POPs).

Division of Technology, Industry and Economics

The mission of the Division of Technology, Industry and Economics (DTIE) is to encourage decision makers in government, local authorities and industry to develop and adopt policies, strategies and practices that are cleaner and safer, make efficient use of natural resources, ensure environmentally sound management of chemicals, and reduce pollution and risks for humans and the environment. In addition, it seeks to enable implementation of conventions and international agreements and encourage the internalisation of environmental costs. UNEP DTIE's strategy in carrying out these objectives is to influence decision-making through partnerships with other international organisations, governmental authorities, business and industry, and non-governmental organisations; facilitate knowledge management through networks; support implementation of conventions; and work closely with UNEP regional offices. The Division, with its Director and Division Office in Paris, consists of one centre and five branches located in Paris, Geneva and Osaka.

Economics and Trade Branch

The Economics and Trade Branch (ETB) is one of the five branches of DTIE. Its mission is to enhance the capacities of countries, especially of developing countries and countries with economies in transition, to integrate environmental considerations into development planning and macroeconomic policies, including trade policies. ETB helps countries to develop and use integrated assessment and incentive tools for sustainable development and poverty reduction. The Branch further works to improve the understanding of environmental, social and economic impacts of trade liberalization and the trade impacts of environmental policies, and to strengthen coherence between Multilateral Environmental Agreements and the WTO. Through its finance initiative, ETB helps enhance the role of the financial sector in moving towards sustainability.

In the field of environmental economics, ETB aims to promote the internalisation of environmental costs and enhance the use of economic instruments to contribute to sustainable development and poverty reduction, including in the specific context of Multilateral Environmental Agreements. The UNEP Working Group on Economic Instruments serves as an advisory body to UNEP-ETB's work programme on economics and has been instrumental in the preparation of UNEP publications on economic instruments.

For more information on the general programme of the Economics and Trade Branch, please contact:

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Executive Summary

Nigeria is Africa's most populous country and agriculture is the centre of activities of its people. The food sub-sector of agriculture includes a large array of crops, made possible by the diversity of agro-ecological production systems and the climate. Rice has emerged as the fastest growing sector and most sought-after commodity in the Nigerian food basket. Because of supply and demand gaps, imports have soared to an unprecedented volume of nearly one million metric tons a year, costing about US$ 1 billion. Nigerian policy in relation to the rice sector is motivated by a range of factors, including the quest for self-sufficiency, national food security, availability of cheap food, curtailment of imports, empowerment of producers through fair input and output prices, poverty reduction and the desire to raise the nutritional value of the average Nigerian diet.

Nigeria began implementing its structural adjustment programme (SAP) in 1986 to re-energise its precarious economy characterised by an adverse balance of payments, severe unemployment, low capacity in the manufacturing sector and a deteriorating quality of life. A battery of fiscal, monetary, salary and trade policies was deployed, with emphasis on market forces, to direct the economy back on the path of balanced, non-inflationary and self-sustaining growth. More crucial reforms were in the trade and exchange rate domains and these involved liberalization of the exchange rate, relaxation of import restrictions, trimming of the import prohibition list and reduction of tariffs on imports. The measures were intended to expose local producers to international competition and fair trade in the spirit of the tenets of the World Trade Organisation (WTO). This study is an integrated assessment of the economic, social and environmental impacts of rice production in Nigeria within the framework of trade liberalization.

In April 2001 The United Nations Environment Programme (UNEP) invited participants from several rice producing countries to a meeting in Geneva to discuss potential studies to assess the economic, social and environmental impacts of the Agreement on Agriculture (AoA). The Nigerian Institute of Social and Economic Research (NISER) prepared a project proposal that was accepted by UNEP, following which a Memorandum of Understanding was signed between both institutions. The other six countries carrying out similar studies are China, Colombia, Côte d'Ivoire, Indonesia, Senegal and Viet Nam.

The project was led by NISER, Nigeria's foremost policy research institute founded in 1950, which set up a multidisciplinary team drawing on the resource personnel available at NISER and the academic and research community in Ibadan, particularly from the University of Ibadan, the International Institute of Tropical Agriculture (IITA) and the West African Rice Development Association (WARDA). The principal research team is made up of five members, namely Tunji Akande, Professor of Agricultural Economics, Specialising in Food Commodity Studies and Agriculture and Rural Development Policy Analysis (team leader of this study); Femi Olokesusi, Professor, Environment and Natural Resource Management; Mrs. Bola Akanji, Snr., Research Fellow, Agricultural Economist with considerable experience in Rural Sociology and Gender Analysis; Godwin Akpokodje, Research Fellow, Economist, with specialised in Quantitative Analysis and Modelling; Jire Adeoye, Reader, Soil Scientist, University of Ibadan/IITA. Stakeholders throughout the rice sector (private and public sector officials) participated in determining the objectives and designing the investigative methodology.

NISER led the team in conducting research for literature and assembling published materials and documents on every aspect of the rice economy in Nigeria and on methodological approaches to analysing trade policy issues. This also involved literature sourced from UNEP, including its manual for integrated assessment of trade-related policies.

The study was launched with a national stakeholders' workshop to introduce the project, define the project objectives, approach and process, and prepare a work programme. The process was largely participatory and inclusive, involving a wide range of stakeholders, including rice farmers, processors, marketers, consumers, research institutes, policy makers, input suppliers and service providers. The interaction with stakeholders was facilitated through meetings, workshops and consultations.

An international meeting was held in Geneva on 19-20 February 2003 involving the seven countries taking part in these studies and other members of the international working group on rice set up by UNEP to guide and implement the projects and provide comments (members of this working group are listed in the Acknowledgements). This meeting helped shape the study and redirect project objectives, especially in relation to the methodology, and the participating countries learned from each other's methods.

In Nigeria a National Steering Committee was formed to oversee the running of the study. The team prepared the study instruments and determined that study areas and coverage, then conducted the field survey. The research involved two main activities: technical analysis of soil, water and habitat characteristics; and analysis of the economic, social and environmental impacts. Both activities relied mostly on primary data obtained in a series of surveys conducted in Nigeria's rice-producing areas. Secondary data were sourced from several organisations including the Nigerian Federal Office of Statistics (FOS), the Central Bank of Nigeria (CBN) and the Federal Ministry of Agriculture and Rural Development (FMARD). The various data obtained were subjected to a series of analytical techniques, including regression analysis and cost-benefit ratios. Based on the primary and secondary data collected, the team carried out an analysis and interpretation of the results, summarising the major findings and drawing inferences and conclusions.

The draft final report was presented at the second international meeting in Geneva on 18-20 November 2003, following which written comments were sent by UNEP to the respective study team leaders for incorporation as far as possible into the studies. Whilst UNEP's Economics and Trade Branch (ETB) is the motivating force behind the project in terms of conceptual ideas, financing and technical support, and has been helpful in guiding the progress of the project, full responsibility for the content of this study remains with the authors.

Nigerian trade policy is geared towards: integrating the economy into the global market; progressive liberalization to enhance the competitiveness of domestic industries; effective participation in trade negotiations to harness the benefits of the multilateral trading system; promoting the transfer, acquisition and adoption of appropriate technologies; and supporting regional integration and cooperation.

The export policy is aimed at diversifying the economy's export base and replacing the mono-commodity export orientation configured by the dominant petroleum exports. The import policy is concerned with further liberalization of the import regime to promote efficiency and international competitiveness of domestic producers.

Nigeria aspires to take full advantage of the opportunities and concessions available in international trade relations at bilateral, multilateral, regional or continental levels. This is noticeable in Nigeria's active participation in the Economic Community of West African States (ECOWAS), the African Union (AU), the Cotonou Agreement, the EU – African, Caribbean and Pacific (EU-ACP) Agreement and the Africa Growth and Opportunity Act (AGOA) of the United States of America. Nigeria's positions in relation to the WTO are aligned with those of other developing countries seeking improved market access to developed countries' markets and preferential treatment on account of non-market issues such as food security, poverty reduction, rural development and debt repayment.

Rice is cultivated in virtually all of Nigeria's agro-ecological zones, from the mangrove and swampy ecologies of the River Niger delta in the coastal areas, to the dry zones of the Sahel in the North. The land mass used for rice cultivation has shot up from a mere 150,000 hectares in the 1960s to about 1.8 million hectares currently. Nigeria has depended largely on extensification to improve production. Yields are low, averaging 1.9 tons per hectare. Rain fed lowland rice is the most predominant rice production system, accounting for nearly 50 per cent of the total rice-growing area in Nigeria; 30 per cent of production is rain fed upland rice, while just 16 per cent is high yielding irrigated systems. Other production systems make up the remaining 4 per cent.

Paddy processing is usually contracted out, but is also sometimes carried out by the farmers themselves. Processing involves parboiling and then milling. Processing efficiency is low and as much as 49 per cent of the grains are broken in the milling process. Small mills that can only handle about one ton/hour dominate the milling process.

Rice marketing is now fully in the hands of private businesses, whereas in the past the Government intervened through the operations of the former Nigerian Grains Board. Farmers sell paddy rice to assemblers and processors, who in turn sell milled rice to wholesalers and other traders who handle bulk. Milled rice moves from wholesalers to retailers and ultimately reaches the final consumers in cities and villages across the country.

The economic impacts of rice production in Nigeria are mainly in terms of income and employment at five main levels: production, processing, marketing, food vending and external (import) trade levels. The gross margin from one hectare of rice-field rose from about N 3,388 in the pre-liberalization period to about N 19,465 after liberalization. However, the return on farmers' investments was less impressive since it declined from 0.57 per naira invested in pre-liberalization to 0.36 after liberalization.

Rice cultivation is increasingly generating employment for new farmers, while established farmers are diversifying into rice cultivation instead of traditional crops and tree crops, such as cocoa and rubber, for which prices have been largely unpredictable for several years.

Income and employment in rice processing have also been substantial. Survey results show that processor incomes rose from about N 32,000 in the pre-liberalization era to about N 136,000 in the post-liberalization era, a more than four-fold increase. Following an increase in activities at the processing level employment has risen, with the average number of employees per mill rising from seven in the pre-liberalization period to 19 after liberalization.

Similarly, income at the rice-marketing level has risen four-fold, indicating an increase in the commercialisation of rice since liberalization. More rice marketers now operate at itinerant and retail market levels and restaurants. Cooked food outlets provide employment for thousands of school leavers. Rice importation and distribution has also become a major generator of employment with wholesale traders and importing firms.

The positive social impacts of rice activities include: food supply; nutrition; the general well being of producing households and families; social interaction and cohesion; improved awareness and general education; and the development of infrastructures in rice producing areas. Negative health effects are indicated by the prevalence of diseases such as malaria, schistomiasis and guinea worm.

The positive economic impacts of rice production in Nigeria include increased reliance on local production, farm income and employment, as well as improved nutrition, etc. The aggregate value of all these positive aspects is encapsulated in the concept of the gross margin analysis that measures the excess of returns over expenses in rice production. The economic value added of rice production was estimated at N 65.6 billion in 2000, N 95.1 billion in 2003 and is projected to reach N 170.2 billion in 2010. The social value of rice production is subsumed in the economic valuation since most of the social impacts such as employment, income, etc. have economic significance.

Environmental impacts are mostly negative and include increased land conversion, deforestation, loss of biodiversity, soil degradation, water logging, deterioration in the quality of water resources and general environmental pollution. The willingness-to-pay approach (WTP) was used to valuate the environmental impact of rice production and estimate the amount producers were willing to make available from their profits for environmental control and management. A sum of N 1 million was obtained from about 90 farmers. When this figure was extrapolated to a total of approximately 250,000 rice farmers throughout the country, the sum obtained was N 250 billion annually.

The end goal of this study is to build national capacity in understanding the implications of trade liberalization and multilateral trade rules on national sustainable development whilst preserving the environment. The findings informed a package of policies to strengthen the positive environmental impacts of rice production on the environment and mitigate the negative ones. A framework for implementing the proposed policies was developed as well as the financial requirements for an effective implementation strategy. These policy initiatives aim to ensure sustainable rice production. The proposed measures include: soil and water quality management, integrated pest control measures, promotion of organic farming, biodiversity conservation, general awareness campaigns, enforcement of existing standards and measures, use of market incentives, environmental monitoring activities, additional environmental research, and improved legal and institutional arrangements.

Nigeria should deploy its existing institutional capacity for environmental management to establish a monitoring and policy implementation body. This body should include Government institutions as well as other stakeholders. The tasks of this body would include, *inter alia*, reviewing the various policy proposals of this study and initiating plans for their implementation.

This project has generated considerable experience and perception in several ways. The study revealed the importance of rice as a source of food as well as a provider of income and employment with increasing numbers of farmers switching from traditional crops (cocoa, rubber, palm produce) to rice production. It has equally accentuated the divergent interests that stakeholders pursue and how each tries to maximize his gains and pass off negative outcomes to others. However, the study also demonstrates that consensus can be reached when it is based on the understanding and appreciation of the concerns and points of view of others. The interaction helped to consolidate existing alliances and broaden the consultative mechanism needed to ensure effective development and realize stated objectives, namely in preventing or ameliorating the negative consequences of expanding rice production in view of achieving self-sufficiency. However, the project experience also revealed that rice producers still have reservations regarding the Government's expansion plans due to the historically unstable nature of Government policies, and the fear that insufficient incentives (inputs, services, etc.) will be provided to guarantee profitable rice production.

Analyses have shown that the environmental impacts in particular call for serious considerations and ameliorative measures, since the cumulative impact of the activities of numerous farmers, irrespective of technological practices, could affect the biodiversity in a way that makes production unsustainable. The proposed monitoring body, if allowed to function effectively, will prevent unnecessary environmental deterioration.

Improvements in infrastructures are also necessary to raise the living standards of rice producing communities, reduce post harvest losses, and improve the quality of domestically produce rice. But the study also revealed that current available data is irregular, divergent and inconsistent, and needs to be cleaned up so that it more adequately reflects developments in the rice sector.

Finally, the project highlights the need for further studies on trade effects and domestic production policies on agricultural output in Nigeria. There is a need for more enlightenment on the role of the WTO in international trade, and how the WTO disciplines affect Nigeria's efforts and drive towards domestic food self-sufficiency and food security concerns.

Abbreviations and Acronyms

ACP	African, Caribbean and the Pacific
ADP	Agriculture Development Projects
AGOA	Africa Growth and Opportunity Act
AoA	Agreement on Agriculture
CBN	Central Bank of Nigeria
CBO	Community-Based Organisations
CGE	Computable General Equilibrium Model
DTIE	Division of Technology, Industry and Economics
ECOWAS	Economic Community of West African States
ETB	Economics and Trade Branch
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FMARD	Federal Ministry of Agriculture and Rural Development
FME	Federal Ministry of Environment
FOS	Federal Office of Statistics
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEF	Global Environment Facility
GM	Genetically Modified
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IEC	Information, Education and Communication
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
ISFM	Integrated Soil Fertility Management
ISO	International Standard Organisation
MFN	Most Favoured Nations
NAERLS	National Agricultural Extension and Rural Liaison Services
NCRI	National Cereal Research Institute
NERICA	New Rice for Africa
NGO	Non-governmental Organisation
NISER	Nigerian Institute of Social and Economic Research
N, P, K	Nitrogen, Phosphorus, Potassium
ODA	Overseas Development Assistance
PTF	Presidential Task force
RYMV	Rice Yellow Mottle Virus
SAP	Structural Adjustment Programme
UEMOA	Union Economique et Monétaire Ouest-Africaine
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WAMZ	West African Monetary Zone
WARDA	West African Rice Development Association
WTO	World Trade Organisation
WTP	Willingness-to-pay

1. Introduction

1.1 Country profile

Nigeria is the most populous country in Africa with over 130 million people, which is nearly a quarter of the continent's total population. There are about 350 ethnic groups, each with unique dietary characteristics and food preferences, so the food culture is as diverse as the ethnic plurality. The natural and human resources available are considerable and make Nigeria Africa's most promising economic and political entity. Nigeria is a federation, consisting of a central federal Government, thirty-six state Governments, a federal capital territory (Abuja) and 774 local Government authorities. After decades of military dictatorship the country has now established itself as a participatory democracy and it is fast emerging as a potentially formidable market-oriented economy, poised to attract the attention of the world. The promotion of equitable and sustainable development, with food self-sufficiency and food security as a cornerstone, has featured prominently in the economic management agenda of the Government.

Nigeria is an oil-producing country and exports over 80 per cent of its crude petroleum. Currently, nearly 95 per cent of the country's foreign exchange earnings come from petroleum exports, and about 90 per cent of Government revenue is derived from the oil sector. It is also realized that production activities in all sectors of the economy are heavily dependent on imported inputs, and consumption patterns throughout society are heavily dependant on imported goods. Since petroleum export earnings provide the source of finance of the import-dependent production and consumption activities, it may be stated that the Nigerian socio-economic system is intricately bound with the fortunes of crude petroleum in the international market.

Nigeria is also among the 20 poorest nations in the world with a gross domestic product (GDP) per capita of only about US$ 300 per annum, an adult literacy level of 57 per cent, and life expectancy of 53 years. Poverty is pervasive, as it is estimated that nearly 65.5 per cent of the population lived below the poverty line (earning less than US$ 1 a day) in 1996. This situation has not changed in spite of Government efforts to address the problem and the desire to achieve the Millennium Goal of reducing poverty by half in 2015. Given the scale of waste and mismanagement in the public sector, but with a substantial level of domestic resources available, the overall challenge is to promote faster, sustainable and more equitable growth by supporting reforms in the agricultural sector and ensuring a more balanced development through effective economic management.

Agriculture is the largest single sector of the economy, providing employment for about two thirds of the nation's work force and constituting the mainstay of Nigeria's large rural community. The proportion of the GDP attributable to agriculture hovers between 30 and 40 per cent, well ahead of mining and quarrying as well as wholesale and retail trade, which are the two other major contributors to GDP in Nigeria.

While agriculture remains dominant in the economy, the food supply does not provide adequate nutrients in terms of either calories or protein at affordable prices for the average citizen[1] and the

[1] Igene, 1991.

nutritional status of both rural and urban dwellers in this largely agrarian country should normally be much higher than has been the case. The daily per capita protein intake from animal sources is under 7g/day, while calorie intake is less than 2,600 calories per capita per day.

From the 1970s the Nigerian food sector has been characterized by excess demand over supply due primarily to a high population growth rate of about 3 per cent per annum, high rates of urbanization and rising per capita income stimulated by both the oil export revenue boom and wage increases. Consequently, food consumption patterns have been changing rapidly, both quantitatively and qualitatively. The increasing emphasis on agricultural growth and development amidst the rapidly growing population partially reflects the concern with which policy makers have viewed the rising demand for food.

1.2 Structural adjustment and liberalization of the economy

The major strengths of the Nigerian economy are its rich agricultural and human resource base and its huge market. Its major weakness is its difficulty in mobilising these resources in a strategic way to diversify the economic base and reduce dependence on oil and imports. Consequently, the economy remains vulnerable to externalities such as changing world prices for crude oil and rising prices of imports. The resulting external and internal imbalances have manifested themselves in an adverse balance of payments position, severe unemployment, low capacity utilisation in manufacturing industries and deteriorating quality of life. This was particularly the case in the early 1980s when the deteriorating international oil market conditions that started in the mid-1970s intensified. The international price of Nigeria's crude oil (the bonny light) dropped from US$ 38 per barrel in 1981 to about US$ 28 per barrel in 1985. Similarly, crude oil output declined from over 2 million barrels per day (mbd) in 1980 to less than 1.5 mbd in 1985. Given Nigeria's already import-dependent production and consumption patterns, the real GDP declined at an average annual rate of 1 per cent resulting in a 4.2 per cent decline in the per capita GDP over the period. Also, given the already huge Government commitment, especially in the area of direct participation in production activities, Government expenditure could not be easily adjusted to the new reality without major consequences for people's welfare. The Government thus decided to maintain its level of expenditure through domestic and external borrowing, but this soon became unsustainable. By 1985, the Nigerian economy was virtually prostrate and required major action if it was to recover.

A notable response to this situation was the adoption of the SAP that emphasised the role of market forces to put the economy back on the path of balanced, non-inflationary and self-sustaining growth. A battery of fiscal, monetary, wage and income policies as well as trade and exchange rate policies was deployed for this purpose. The most crucial reforms in the trade and exchange rate policies were the liberalization of the exchange rate and the application of lower tariffs on imports. Beginning in September 1986, the import licensing system was abolished and an auction-based foreign exchange allocation mechanism was introduced. Specifically, the foreign exchange market was established to resolve the problem of the overvalued currency with the attendant balance-of-payments deficit.

With respect to the trade policy, import restrictions were relaxed and the import prohibition list was trimmed. The tariff structure was intended to expose local producers in all sectors (including agriculture) to international competition while offering them protection against dumping and unfair competition. In 1988, a seven-year tariff structure was introduced and a Tariff Review Board was established to oversee tariff administration and make occasional recommendations to the Government.

The trade policy reforms included several export promotion measures. For example, all export duties were abolished and export licensing was abrogated.

The export prohibition list was abolished soon after the commencement of the SAP in 1986, but in 1987 the export of food grains was banned and, later, exports of raw palm kernel, cassava, yam and hides were also banned. Generous retention schemes were introduced and other incentives such as duty draw back, export insurance, credit guarantee schemes and a refinancing and rediscounting facility by the Central Bank were introduced.

The broad aim of the trade and exchange rate policies was to reduce dependence on the oil sector for foreign exchange while encouraging more efficient manufacturing of goods based on local resources. It was also aimed at discouraging food imports and promoting instead the production of domestic staple crops; boosting the competitiveness of local producers; and broadening non-oil exports, i.e. mainly agricultural products. Evidence clearly shows that the exchange rate depreciated rather precipitously between 1986 and 2002. Specifically, the naira/dollar exchange rate depreciated from an annual average of N 1.27 to the dollar in 1986 and to N 17.30 to the dollar in 1992 and then N 125.00 to the dollar in 2002. However, the objective of reducing dependence on oil for foreign exchange was not realised since the contributions of non-oil exports have hardly exceeded 5 per cent over the years. Similarly, the expected reduction in dependence on imported raw materials did not materialise since these continued to account for an increasing proportion of the total import bill. At the same time, the share of imported consumer goods kept increasing, while inflation and unemployment remained problematic. Given the import-dependent production and consumption structures, the precipitous exchange rate depreciation contributed significantly to the rising production costs and cost of living in Nigeria.

The achievements of the SAP were therefore mixed. While the growth rate of GDP registered a negative trend between 1981 and 1985 (pre-SAP period) with an average of -2 per cent per annum, it rose to about 5.5 per cent per annum during the 1986-1993 (SAP period). The agricultural sector gained particularly from the floating exchange rate that favoured exports of Nigeria's traditional tradable commodities, especially cocoa. Consequently, domestic prices of agricultural export produce rose significantly. Favourable weather conditions and the incentives created by these measures resulted in an increased output of all commodities, which registered about 20-30 per cent annual growth rates between 1986 and 1993. Since Nigeria is a net importer, domestic rice could not benefit directly from the new exchange rate policy. The commodity nevertheless benefited from the reduction in competitive edge that imported rice had over local rice as the former became much more expensive. Rice producers responded by increasing output, which grew by about 7 per cent per annum during the SAP period (CBN/NISER, 1992). Overall, the agricultural GDP grew by 3.39 per cent.

However, the increasing depreciation of the naira, both official and unofficial, during the SAP period caused the inflation rate to jump from 5.3 per cent in 1986 (pre-SAP period) to 33.4 per cent in 1992. This seriously eroded the purchasing power of the average Nigerian. Thus, while some distortions were removed from the economy after the SAP was initiated in September 1986, the overall performance of the economy indicates that the objectives envisaged in the programme were not fully achieved. The economy continued to face severe structural and financial imbalances as shown by rising inflation. Nigeria continues to be basically a one-commodity economy, relying on petroleum for 90 per cent of its foreign exchange earnings and 80 per cent of Government revenues. The intended objective of diversifying the productive base of the economy was not achieved through structural adjustment. Prominent among the factors that have contributed to the limited achievements of the SAP in Nigeria was the poor implementation of macroeconomic policies, largely due to political instability and frequent changes in leadership, especially at the ministerial level, as well as the realisation of the negative impact of SAP measures on social welfare, necessitating a re-think of several policy aspects.

2. Background to the project

2.1 Relevance of the rice sector to the national economy

The food sub-sector of Nigerian agriculture boasts a large array of staple crops, made possible by the diversity of agro-ecological production systems. The major food crops are: cereals (sorghum, maize, millet, and rice); roots and tubers (yam and cassava); legumes (groundnut and cowpeas) and others (fruits and vegetables). These commodities are of considerable importance for food security, expenditures and household incomes.

Of all the staple crops, rice has risen to a position of pre-eminence. At independence in 1960, rice was merely a festival food consumed mostly in affluent homes at Christmas and during other religious festivals. However, the report by Akpokoje *et al.* (2001) indicates that since the mid-1970s rice consumption in Nigeria has risen tremendously, (+10.3 per cent per annum), a result of the accelerating population growth rate (+2.8 per cent per annum) and increasing per capita consumption (+7.3 per cent per annum). In the West African sub-region the consumption of rice has been increasing at a much faster rate in Nigeria than in the other West African countries since the mid-1970s (see Table 2.1). For example, during the 1960's Nigeria had the lowest per capita annual consumption of rice in the sub-region (average of 3 kg). Since then, Nigerian per capita consumption levels have grown significantly at 7.3 per cent per annum. Consequently, per capita consumption during the 1980's averaged 18 kg, reaching 22 kg between 1995 and 1999. Despite catching up with the rest of West Africa in terms of per capita consumption, the Nigerian consumption levels are still lower than for the rest of the sub-region (34 kg between 1995 and 1999). Increases in average growth rates in Nigerian per capita rice consumption are likely to continue for some time.

A combination of various factors seems to have triggered the increase in rice consumption, including rapid urbanization, ease of preparation that fits easily with the urban lifestyle of workers, and general availability among food vendors and restaurants located in work places in urban areas. Indeed, rice is no longer a luxury food in Nigeria and has become a major source of calories for the urban poor. For example, the poorest third of urban households obtain 33 per cent of their cereal-based calories from rice, and rice purchases represent a major proportion of expenditure on cereals.[2] Rice availability and prices have become a major welfare determinant for the poorest consumers who also are least food-secure.

Rice production in Nigeria has expanded too since the 1970s (+9.3 per cent per annum), particularly as a result of vast increases in the rice-growing area (+7.9 per cent per annum) and to a lesser extent through yield increases (+1.4 per cent per annum). Notwithstanding, the production increase was insufficient to match increased consumer demand and imports make up the shortfall. Quantities imported have oscillated widely over this period, but lately have surged from 300,000 metric tons in 1995 to about 1,000,000 metric tons in 2001. These imports are procured on the world market and

[2] World Bank, 1991.

Table 2.1: Rice-related trends in Nigeria and the rest of West Africa

Indicators	Means 1961-75	Means 1976-83	Means 1984-95	Means 1996-99
Nigeria				
Production (tons)	332,800	806,222	2,306,794	3,189,833
Import (tons)	2,036	420,756	334,974	525,307
Self-reliance ratio (%)	99%	54%	77%	79%
Total Consumption	178,199	833,640	1,599,609	2,248,113
Per capita consumption (kg)	3	12	18	22
West Africa without Nigeria				
Production (tons)	1,779,376	2,344,073	2,822,635	4,041,384
Import (tons)	416,183	894,073	1,760,884	2,107,146
Self-reliance ratio (%)	65%	56%	42%	50%
Total Consumption (tons)	1,178,753	1,950,821	2,973,885	3,985,721
Per capital consumption (kg)	21	27	30	34

Source: Akpokodje *et al.,* 2001, p.2.

represent a substantial cash outlay for the Nigerian economy. The Nigerian President publicly complained of the unacceptably huge foreign exchange outlay of as much as about US$ 1 billion annually to import rice alone. Nigeria has, therefore, decided to double her present output in order to become self-sufficient in rice by the year 2005 and a net exporter by 2007.

Thus, rice has become a critical commodity in the Nigerian economy and this has compelled the Nigerian Government to continually intervene in the rice sector over the past few decades. Public policy in this respect has been neither consistent nor appropriate and as a result, domestic production has continued to lag behind demand. Given the current globalisation trend, an increasingly competitive world economy and WTO disciplines, Nigeria faces a number of strategic choices in relation to her rice sector.

Inevitably, the Nigerian Government has been somewhat concerned with rice. First, Nigeria's self-sufficiency in rice production is low. Imported rice tends to dominate the markets in the urban centres, and imports, which average over 1 million metric tons annually, still show the potential of continuing to grow. This level of imports in a country that possesses varying and abundant agro-ecological and other natural resources that are suitable for rice production can only be worrisome. Second, apart from food supply and food security being key issues in the Nigerian Government's economic agenda, rice is perceived as playing a significant role in the country's food security objectives, as both the poor and the wealthy consume the commodity. The urban poor in particular are said to spend a third of their disposable income on rice. Rice is said to be more palatable and nutritious than the other coarse grains produced in Nigeria.[3] Thus, rice can also help meet the nutritional needs of the poor. Rice has become the fastest growing and widely consumed food in Nigeria today. The per capita consumption is expected to continue to grow in the coming years. This makes it imperative for the Government to take an interest in ensuring the availability of rice. Third, rice is a crop that can help raise the wealth base of rural communities and address the poverty problem in rural areas because rice cultivation generates substantial farm income, which is why it is being cultivated as a substitute to traditional cash crops.

[3] World Bank, 1991.

Nigerian policy in relation to the rice sector appears to be motivated by a whole range of factors and circumstances including (i) the desire to curtail unfair competition from imported rice, (ii) the quest for self-sufficiency and national food security, (iii) the challenge of reducing poverty and raising farmers' incomes, (iv) the need to generate increased employment by encouraging school leavers to go into rice production, (v) the desire to reverse the heavy outflows of foreign exchange for rice imports, and (vi) the desire to raise the nutritional level of the average Nigerian by making domestic rice available at affordable prices. These objectives are unassailable. Indeed, several studies[4] that will be discussed later in this document have clearly shown that rice production is profitable for the farmer in relation to other crops, irrespective of the production system and technology used. Akande and Fasasi (2003) and Okuneye and Babalola (2003) have also shown that farmers are diversifying from cocoa and other tree crops into rice production because of the income they derive from the latter. While the current Government policy on rice tends to consolidate the gains that local rice producers now derive, the approach and methodology adopted (for instance, 100 per cent tariff and subsidisation of the rice sector) tend to undermine free trade and are, therefore, antithetical to the spirit of the WTO AoA, which rejects any form of trade restrictions because of the perceived deleterious effects such restrictions have on efficiency of resource use and general welfare. As a signatory and ongoing negotiator, Nigeria needs to enhance its negotiating capacity at the WTO and its understanding of the implications of multilateral trade rules and trade liberalization on national sustainable development and the environment. There is also the need to ascertain the economic, social and environmental implications of implementing the WTO AoA on the rice sector with the objective of generating appropriate domestic policies to promote rice production.

In summary, given the current competitive, liberalized and globalized world economy and the demand for economic, social and political stability and meeting the challenge of environmental sustainability, Nigeria faces strategic choices in relation to her rice economy. This project attempts to address these apparent contradictions in the rice sector with a view to putting Nigeria on a path of sustainable macroeconomic and sectoral development without endangering her commitment to global agreements and protocols such as the WTO AoA. Specifically, the project will examine, within a cost-benefit analytical framework, the economic, social and environmental impacts of trade liberalization and the AoA on the Nigerian rice sector.

2.2 Project objectives and hypothesis

The overall objective of the project is to conduct an integrated assessment of the economic, social and environmental impacts of rice production in Nigeria within the trade liberalization framework, with a view to improving its understanding of the implications of multilateral trade rules and trade liberalization on national sustainable development and the environment and strengthening Nigeria's negotiating capacity at WTO talks relating to the production and trade of primary staple foods. The specific objectives are to:

- characterise the Nigerian rice sector (production, processing, marketing, consumption and policy)
- conduct integrated assessments of the economic, social and environmental impacts of trade liberalization for the rice sector
- develop policy packages to strengthen the positive impacts and ameliorate the negative impacts of rice production on the environment
- provide financial implications for the implementation of recommended policies

[4] Olagoke, 1991; Okorji and Owuka, 1994; Nwoye, 1997 and Fabusoro, 2000.

– identify and propose agencies and institutions to carry out the implementation.

The hypotheses that guide the study are:

– rice production has no impact on the Nigerian economy, at national and household levels

– rice production has no social impact for Nigeria

– rice production has no impact on the Nigerian environment.

2.3 Process and in-country methodology

UNEP is the motivating force behind the project in terms of conceptual ideas, financing and technical support. UNEP's ETB staff has been helpful in guiding the progress of the project. They are, however, absolved from any shortcomings apparent in the project.

The approach adopted in the project was to involve all stakeholders in the rice sector (private and public sector officials) in designing the investigations needed to elucidate the stated objectives that were also decided upon in a participatory manner. The steps taken by the host institution may be summarised as follows:

– preparation of a proposal to UNEP and its subsequent approval after modifications;

– setting up of a multidisciplinary team drawing on the resource personnel available at NISER and the academic and research community at Ibadan, particularly from the University of Ibadan, the IITA and WARDA;

– conducting research for literature and assembling published materials and documents on every aspect of the rice economy in Nigeria and on methodological approaches to analysing trade policy issues. This also involved literature sourced from UNEP, including the manual for integrated assessment of trade-related policies;

– convening a national stakeholders' workshop to introduce the project. The workshop defined the project objectives, the approach and the process and also prepared a work programme;

– establishment of a National Steering Committee to oversee the running of the study;

– preparation of study instruments and determination of areas of study and coverage;

– conducting a field survey, embracing economic, social and environmental indicators and extensive assessment of the soil and physical environment;

– analysis of survey data and interpretation of results; summarising the major findings and drawing of inferences and conclusions;

– preparation of study report for peer-review and upgrading.

NISER is the national institution housing the project and is Nigeria's foremost policy research institute founded in 1950. It is a multidisciplinary institute consisting of six departments, four units and a centre as follows:

– Agriculture and Rural Development Department
– Economic Development Department
– Human Resources Development Department
– Physical Development Department
– Social Development Department
– Technology Development Department
– Political Development Unit
– Macroeconomic and Strategic Modelling Unit
– Rural Policy Analysis and Management Unit
– Transport Studies Unit
– African Regional Centre for Indigenous Knowledge

The principal research team consists of five members, namely Tunji Akande, Professor of Agricultural Economics, Specialising in Food Commodity Studies and Agriculture and Rural Development Policy Analysis (team leader of this study); Femi Olokesusi, Professor, Environment and Natural Resource Management; Mrs. Bola Akanji, Snr., Research Fellow, Agricultural Economist with considerable experience in Rural Sociology and Gender Analysis; Godwin Akpokodje, Research Fellow, Economist, specialist in Quantitative Analysis and Modelling; Jire Adeoye, Reader, Soil Scientist, University of Ibadan/IITA.

2.4 Development of in-country methodology

The nature of the project and the specified objectives dictated the methodological choice. The project has two components: (i) the involvement and sensitisation of stakeholders in the rice sector and (ii) an empirical study. Both obviously require different approaches.

Process and capacity building aspects

The process has been participatory and inclusive. Sensitisation of stakeholders was first initiated through communications and contacts. It was not difficult to enlist the interest of various key stakeholders because the present study benefited from an earlier study undertaken by WARDA and NISER examining the competitiveness of rice production in Nigeria. All key players in the rice sector, including producers, processors, marketers, consumers, policy makers and service providers were first identified and enlisted for participation in a stakeholders' meeting during which the objectives and methodology for the study were developed. The participatory process was adopted to ensure the findings and recommendations emanating from the project received inputs from stakeholders and, as such, were found acceptable for implementation by policy makers. Interactions with stakeholders were in the form of meetings, workshops and consultations. To strengthen the policy package and its implementation, policy makers were key players in the steering committee and at the national stakeholders meetings.

Survey methods used

The research component of the study involved two main groups of activities: (a) technical analysis and (b) economic, social and environmental impact analysis. The technical analysis relates to biophysical and chemical analyses of the rice-producing environment and the determination of the effects of agro-chemicals on the environment and biodiversity. This essentially involved chemical analysis of water, soil and plant samples taken from rice producing centres to determine the concentration of chemical and agro-chemical residues in the surrounding water, soil or plants and deduce the implications for environmental and production sustainability. A soil and environmental scientist carried out field exercises and laboratory analysis and assessed soil erosion, soil degradation and the effects of waterlogging as well as other physical features in rice production areas.

Socio-economic analyses focused essentially on the economics of rice production, processing, trade and consumption. It examined the motivation and involvement of different participants in the rice sector, issues of poverty, self-sufficiency, nutrition, profitability, enterprise substitution, etc. Both primary and secondary data were used. Secondary data were obtained from statutory data-collection institutions (FOS; CBN; FMARD, the Federal Ministry of Environment (FME) and the Federal Ministry of Commerce) as well as from regional offices of international organisations (FAO, USAID, UNDP and the World Bank).

Primary data were sourced from producers, processors, traders and consumers. Different sets of questionnaires, which addressed economic, social and environmental issues were prepared and applied to the different categories of respondents. The survey was conducted in areas of intense rice-related activity identified in Ekiti, Benue and Niger states of Nigeria. To complement the formal surveys, participatory methodologies (focus group discussions, key informant interviews and participant observations) were also used. In addition, policy dialogues and consultations were held before, during and after the field survey.

Various analytical tools were used to elucidate different aspects of the study. Gross margin analysis was used to examine issues related to profitability as an indication of the incentive for producers to remain in rice production. Cost-benefit analyses were conducted to justify the use or non-use of agro-chemicals from the point of view of farmers and society. The issue here is to compare farmers' practices with what is socially desirable. We have also used summary statistics (means and frequencies) to characterise assembled data.

3. Trade liberalization policies in Nigeria

3.1 Trade policy objectives

Nigeria's trade policy is geared towards encouraging the production and distribution of goods and services to satisfy domestic and international markets as well as to accelerate and achieve economic growth and development. It is recognised that the trade policy must be accompanied by desirable domestic measures in order to foster innovation, predictability, transparency, rule of law and international competitiveness. Against this philosophical background, some of Nigeria's trade policy objectives encompass the following:

- integration of the Nigerian economy into the global market system
- promotion and diversification of exports in both traditional and non-traditional markets
- progressive liberalization of the import regime to enhance competitiveness of domestic industries
- effective participation in trade negotiations to enhance the achievement of national economic gains in the multilateral trading system, as well as regional and bilateral arrangements
- promotion of transfer, acquisition and adoption of appropriate and sustainable technologies to ensure competitiveness of export-oriented industries
- promotion of regional integration and cooperation.

To achieve these objectives the Nigerian Government has attempted to create a framework that is conducive to the free play of market forces to guarantee private enterprise and economic freedom in areas such as new investments, new technologies, enhanced manufacturing value added and expanding exports. The Government's role is that of a facilitator promoting competitiveness, improving physical infrastructure and formulating effective policies for export growth.

3.2 Export and import policies

The pattern of Nigeria's exports changed somewhat radically in the early 1970s when petroleum exports displaced agricultural exports, which hitherto dominated the export volume and value. Since then oil has accounted for nearly 90 per cent of Nigeria's export earnings. The present concern in export policy is how to diversify the export base of the economy. The export policy objectives are thus focused on expanding the marketability of Nigeria's export commodities through product diversification, improving support services to exporters and export-oriented industries, consolidating existing export markets, creating new markets, diversifying and increasing exports of high value-added manufactured products that depend on natural resources where Nigeria has a comparative advantage, and encouraging the acquisition and adaptation of environmentally friendly technologies to ensure that Nigeria's products meet international standards.

The main objective of the import policy is to further liberalise the import regime whilst promoting the efficiency and international competitiveness of domestic industries. In this respect the Government is attempting to facilitate and liberalise the import procedure and eliminate quantitative restrictions on traded goods and services, without jeopardising the interests of

domestic producers. Effective machinery has been put in place to ease the difficulties faced by importers such as delays and the arbitrariness of Government agencies. An effective and transparent tax administration system, customs administration and commercial courts are already in place to minimise corruption within Government agencies.

The Government has also opened up avenues of negotiation capable of promoting free trade through bilateral and multilateral development cooperation, agreements and trade interests. The aim is to ensure that Nigeria derives maximum benefit from participating in international trade negotiations through the creation of favourable market access conditions for its export products at the bilateral, regional and multilateral levels. The country endeavours to take full advantage of the opportunities and concessions through its participation in international trade relations, especially within the ECOWAS sub-region. Under the Fast Track programme, the Government of Nigeria is poised to promote cooperation and development in all areas of economic activity and improve the standard of living of the peoples of West Africa. Nigeria also plans to take advantage of opportunities offered by the AGOA of the United States of America and the new EU-ACP Agreement. The main goal of the Government's policy in this respect is to improve the country's economic performance by reversing the adverse balance of payments and eliminating payment difficulties. Through this means, the Nigerian Government expects that the nation's exports will increase, particularly to countries with which it has already signed bilateral trade agreements or preferential trade agreements. It is also envisaged for Nigeria to conclude agreements with other countries that could be potential markets for her goods and services.

3.3 Changes and sequence in the rice policy environment

From an historical perspective, Nigeria's rice policy can be discussed in reference to three important periods: the pre-ban, ban and post-ban periods. The pre-ban period from 1971 to 1985 was prior to the introduction of absolute quantitative restrictions on rice imports and may be divided into two sub-periods, namely the pre-crisis (1971-1980) and crisis (1981-1985) periods. The pre-crisis period was largely characterized by liberal policies on rice imports, although ad hoc measures were implemented during temporary shortages. More stringent policies were instituted during the crisis period but did not include outright bans. During the ban period from 1986 to 1995, rice imports were illegal, however illegal rice imports thrived. In the post-ban period, from 1995 onwards, quantitative restrictions on rice imports were lifted and the country adopted a more liberal trade policy for rice.

During the pre-ban period (before 1986), Government policies had artificially lowered domestic rice and fertilizer prices relative to world market prices. This was the consequence of several factors:

- massive importation of rice between 1975 and 1985 caused the price of domestically produced rice to drop;
- the Government was involved in the distribution and marketing of the imported rice but it absorbed the costs of doing so rather than transferring these costs to consumers;
- elite urban consumers were protected at the expense of farmers, leading to depressed farm gate prices;
- producers were protected through input subsidies, which at least reduced some of the burden of production costs.

The ban on rice imports came into effect in 1985. It was anticipated that it would stimulate domestic production as a result of the increase in the price of rice. With the introduction of the SAP in 1986 this ban was reinforced and various trade policies were instituted. In addition, the value of the naira depreciated as a result of the exchange rate deregulation. The overvalued exchange rate had served as an implicit tax on rice producers as it made imported rice relatively cheaper.

Nigeria has employed various international trade policy instruments such as tariffs, import restrictions and outright bans on rice imports at various times (see Table 3.1). During the 1970s and early 1980s,

Table 3.1: Chronology of Nigeria's trade policy on rice

Period	Policy Measures
Prior to April 1974	66.6% tariff
April 1974-April 1975	20% tariff
April 1977-April 1978	10% tariff
April 1978-June 1978	20% tariff
June 1978-October 1978	19% tariff
October 1978-April 1979	Imports in containers under 50kg were banned
April 1979	Imports under restricted license only for Government Agencies
September 1979	6-month ban on all rice imports
January 1980	Import license issued for 200,000 tons of rice
October 1980	Rice under general import license with no quantitative restrictions
December 1980	Presidential Task Force (PTF) on rice was created and it used the Nigerian National Supply Company to issue allocations to customers and traders
May 1982	PTF commenced issuing of allocations directly to customers and traders in addition to those issued by NNSC
January 1984	PTF disbanded. Rice importation placed under general license restrictions
October 1985	Importation of rice (and maize) banned
July 1986	Introduction of SAP and the abolition of Commodity Boards to provide production incentives to farmers through increased producer prices
1995	100% tariff
1996	50% tariff
1998	50% tariff
1999	50% tariff
2000	50% tariff
2001	85% tariff
2002 (April)	100% tariff. Presidential committee on rice production expansion was set up to help Nigeria become self-sufficient in rice by 2004 and a net exporter by 2005!
2003	150% tariff

Sources: Sutcliffe and Ayomike, 1986; Federal Government Budgets, 1984-1986, 1995-2003; SAP and the Nigerian Economy, 1987; http://oryza.com/africa/nigeria/index.shtml

increased export earnings coupled with the highly over-valued naira exchange rate facilitated Nigeria's huge food imports. However, because these imports were cheaper as a result of the exchange rate, they contributed to depressing domestic prices, which eroded the competitiveness of domestically produced rice and served as major disincentive to rice farmers.

Rice policies have been somewhat erratic. For instance, from 1986 to the mid-1990s rice imports were illegal. In 1995 imports were allowed at a 100 per cent tariff. In 1996 the tariff was reduced to 50 per cent.[5] In April 2002, the tariff on imports was again increased to 100 per cent. This erratic policy reflects the dilemma of both securing cheap rice for consumers and ensuring a fair price for producers.

The WTO AoA tends to disapprove of trade-related restrictions as these can distort trade and welfare. The Nigerian Government does not appear to go along with the AoA for good reasons, since imported rice tends to depress local prices and out-compete domestic rice causing domestic producers to lose substantial income and sometimes produce at a loss. Furthermore, the demand for domestic rice is low because of its poor quality arising from processing difficulties. The cost of transporting the produce to markets has also become prohibitive in recent years due to high petroleum prices, inadequate vehicles and the collapse of the railway transportation system.

Consumer demand continues to increase and rice is gradually becoming a socially explosive and political food commodity. The producers' association has mounted considerable pressure on the Government to protect producers and provide subsidies to boost local production. The Government has responded by raising the tariff on rice imports to 100 per cent, and has also commenced arrangements for the provision of subsidies

[5] Akande, 1998.

on production inputs and of micro-credits at concessionary interest rates of less than 10 per cent (the prime lending-rate at commercial banks is about 25 per cent). In addition, the FMARD has reached an agreement with WARDA to promote New Rice for Africa (NERICA), a new rice variety produced by WARDA scientists and which is said to possess unprecedented qualities in terms of yield and nutrition. Recently, the Government set up a "Presidential Committee on Rice" to explore all possible strategies for Nigeria to become self-sufficient by 2005 and a net exporter by 2007.

3.4 Regional agreements

Nigeria is a key player in the ECOWAS sub-region. ECOWAS is a regional organisation concerned with economic, social and political matters in West Africa. Specifically, ECOWAS is concerned with deepening cooperation and integration in the region. In this respect, the countries in the region, including Nigeria, have engaged in regional agreements which in recent years have included ECOWAS Monetary Cooperation Programme, Statutes of the West African Monetary Zone (WAMZ) and establishment of a common Central Bank under the Fast Track Initiative. The decision has also been taken to establish, as soon as possible, a Customs Union in ECOWAS based on the lowest existing common tariff in the sub-region, which ranges from zero to 20 per cent. A Second WAMZ has been established. This covers the non-CFA Franc, or non-Union Economique Monétaire Ouest-Africaine (UEMOA) West Africa, i.e. Nigeria, Ghana, Sierra Leone, Liberia, Guinea and The Gambia. The plan is that WAMZ will in future merge with the UEMOA to create a single monetary union to facilitate trade and the legal movement of people and goods throughout the region.

3.5 WTO positions

Nigeria has been a participating member country at WTO negotiations. Its position in these negotiations is aligned with that of the great majority of African countries, particularly ECOWAS countries, and takes into account issues of market access, food security and self-sufficiency goals, poverty reduction, rural development, the role of agriculture in national development and other non-trade issues that are of importance to developing countries. The reduction in market access barriers as a result of WTO Agreements has potentially positive implications for expanding international trade. However, for African countries the prospects are mixed. First, in spite of the liberalization measures, the products for which African countries have the best export opportunities face the highest tariff barriers in the main importing countries. Secondly, with the reduction of the Most Favoured Nations (MFN) rates, African countries have now lost substantial preferential margins as LDCs or ACP countries. Finally, non-tariff barriers continue to limit market access.

The individual domestic economy also faces some restrictions and limitations imposed by WTO Agreements on domestic measures, such as export and production subsidies. Although African countries, including Nigeria, are exempted from these for the time being, the long-term implication is that these countries would need to improve on productivity, efficiency, managerial skills and diversification strategies, if they hope to harness the benefits of globalization and liberalization.

As a member of the African, Caribbean and Pacific (ACP) group, Nigeria has been benefiting for almost 28 years from the Cotonou Agreement in terms of preferential market access to the EU compared to other EU trading partners. The agreement comes to an end in 2008 but the non-reciprocal trade preference may be retained for a transition period.

Derogation from Article 1 of the General Agreement on Tariffs and Trade (GATT) to implement the New EU-ACP Partnership Agreement (The Cotonou Agreement) was obtained at the WTO meeting in Doha for a limited period (up to 2008), by which time the regime should have been made compatible with WTO rules. The consequence of the EU Agenda 2000 for trade with ACP states may be a loss of export earnings for the ACP countries, which will certainly affect the global trading pattern.

4. The Nigerian rice economy in perspective

4.1 Production

Rice is cultivated in virtually all of Nigeria's agro-ecological zones, from the mangrove and swamp environments in the coastal areas of the Niger Delta to the dry zones of the Sahel in the North. In the 1960s, the rice-growing area was less than 150,000 hectares and output was below 300,000 metric tons. As can be seen in Table 4.1, by 1980 output had risen to about one million metric tons, the area cultivated had expanded to 550,000 hectares and the yield had increased to about 1.9 metric tons per hectare. By 2000, out of 25 million hectares of total land cultivated in Nigeria, about 6.4 per cent (1.6 million hectares) were used for growing rice. Figure 4.1 shows the trend in terms of area and output, and Figure 4.2 shows the yield levels between 1961 and 2000. During most of the 1990s output increased while yield declined, which suggests extensive rice cultivation with consequent negative environmental impacts.

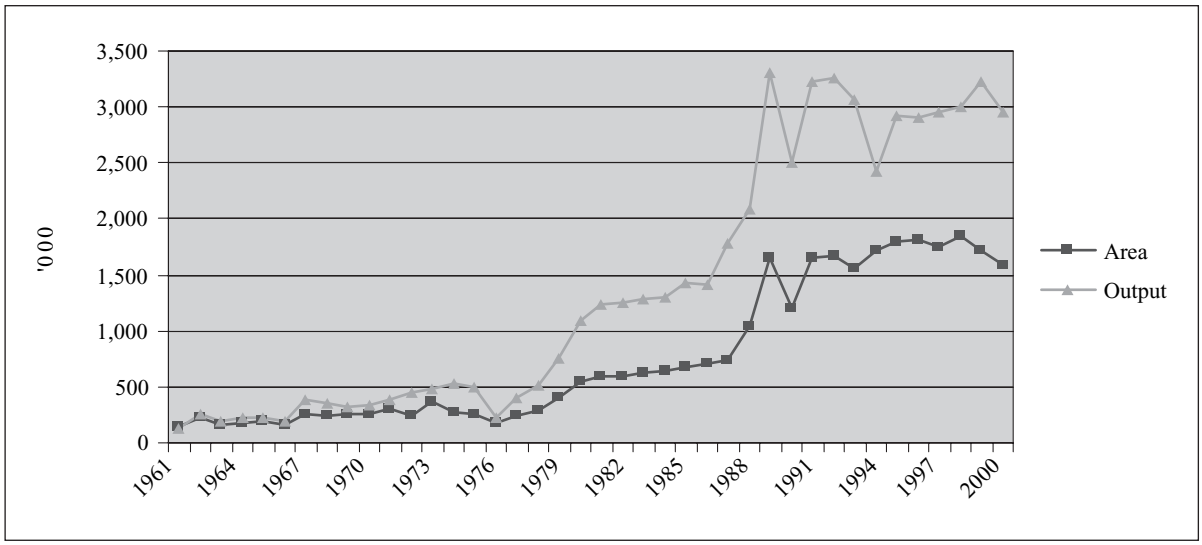
The regional pattern of rice production among the country's six geopolitical zones shows that the Central zone is the highest producer, accounting for about 44 per cent of rice output. The North West follows with 29 per cent, while the North East, South East, South West and South-South account for 14, 6, 4 and 3 per cent respectively. The distribution of rice cultivation across the states in 2000 is shown in Figure 4.3, while Table 4.2 provides actual output and yield for some states. In 2000, Kaduna state was the highest producer, accounting for about 22 per cent of the country's rice output. Niger state, Benue and Taraba followed with 16, 10 and 7 per cent respectively.

Table 4.1: Rice statistics for Nigeria, 1961 – 2000

Period	Area (hectares)	Output (tons)	Yield (tons/hectare)
1961	149,000	133,000	0.893
1965	188,000	231,000	1.229
1970	255,000	343,000	1.345
1975	261,000	504,000	1.931
1980	550,000	1,090,000	1.982
1985	670,000	1,430,000	2.134
1990	1,208,000	2,500,000	2.070
1995	1,796,000	2,920,000	1.626
2000	1,594,840	2,960,280	1.856

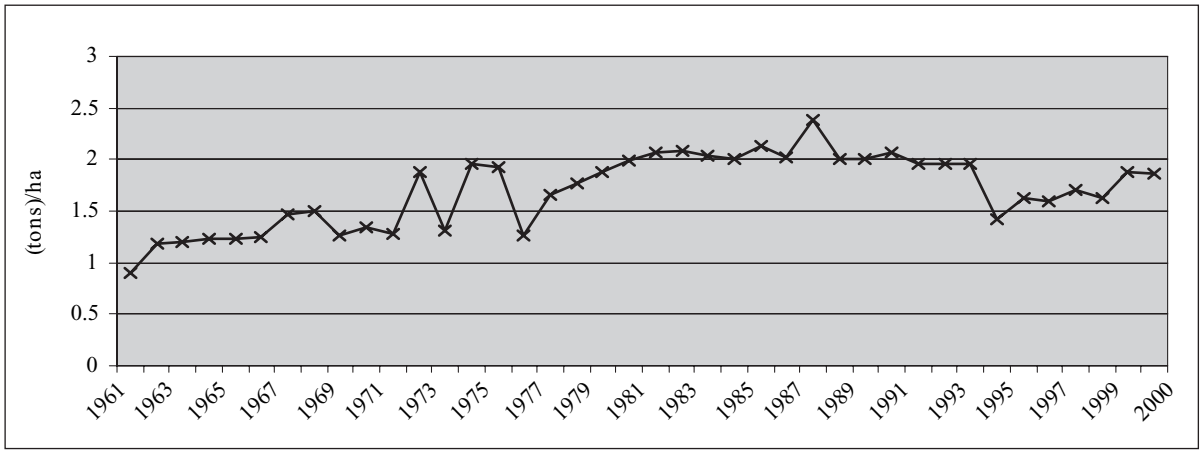
Source: PCU, FMARD, Nigeria.

Figure 4.1: Area and output of rice in Nigeria, 1961 – 2000



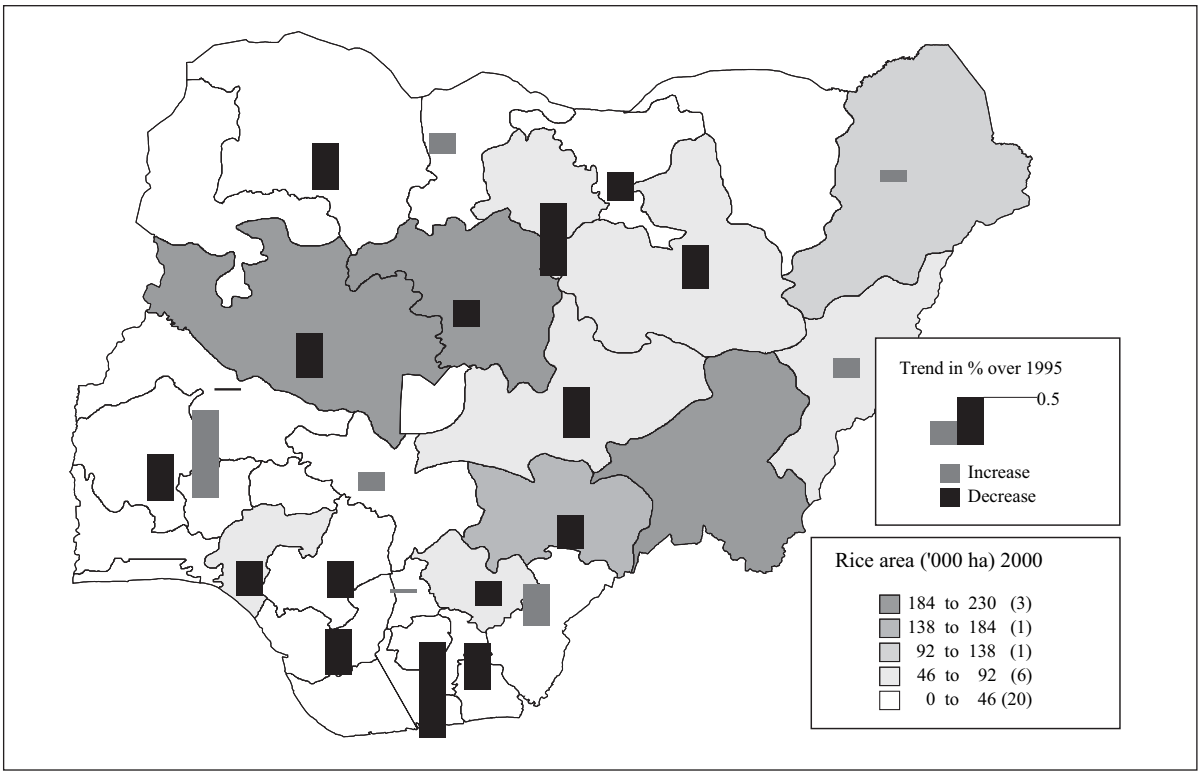
Source: PCU.

Figure 4.2: Yield levels of rice in Nigeria, 1961 – 2000



Source: PCU.

Figure 4.3: Rice cultivation areas in 2000



Source: PCU, 2000.

Table 4.2: Rice output and yield in Nigeria by geopolitical zone and selected states, 2000

S/No	Zone	Output (1,000 tons) Dry seasons	Wet season	Total	Yield (tons/ha) Dry seasons	Wet season
	North West	0.34	847.93	848.27	1.74	2.04
1.	Kaduna		597.73	597.73		2.60
2.	Kebbi	0.34	68.00	68.34	1.74	2.11
	North East	2.93	418.82	421.75	3.31	1.56
1.	Adamawa	0.53	128.00	128.53	3.33	1.97
2.	Borno	2.40	125.00	127.40	3.31	1.36
	North Central	15.50	1,270.17	1,285.67	3.55	1.82
1.	Benue	14.79	275.10	289.89	3.59	1.99
2.	Niger		473.30	473.30		2.30
	South East	2.05	177.25	179.30	2.37	2.35
1.	Imo	0.55	0.16	0.71	1.90	2.67
2.	Ebonyi	1.80	114.87	116.67	2.56	2.53
	South South	0.30	97.90	98.20	2.13	1.63
1.	Cross River		0.15	0.15		1.50
2.	Edo	0.30	8.00	8.30	2.13	1.60
	South West	2.81	115.98	118.79	2.05	1.39
1.	Ogun		12.37	12.37		1.20
2.	Ekiti	1.25	40.09	41.34	1.76	1.07
	National	24.22	2936.05	2960.28	3.05	1.85

Source: PCU, FMARD, 2001.

Production systems

The rice production systems in Nigeria, as Figure 4.4 shows, include rain fed upland, rain fed lowland, irrigated lowland and deep water and mangrove rice.[6] Rice farms tend to be small-scale, averaging one to two hectares.

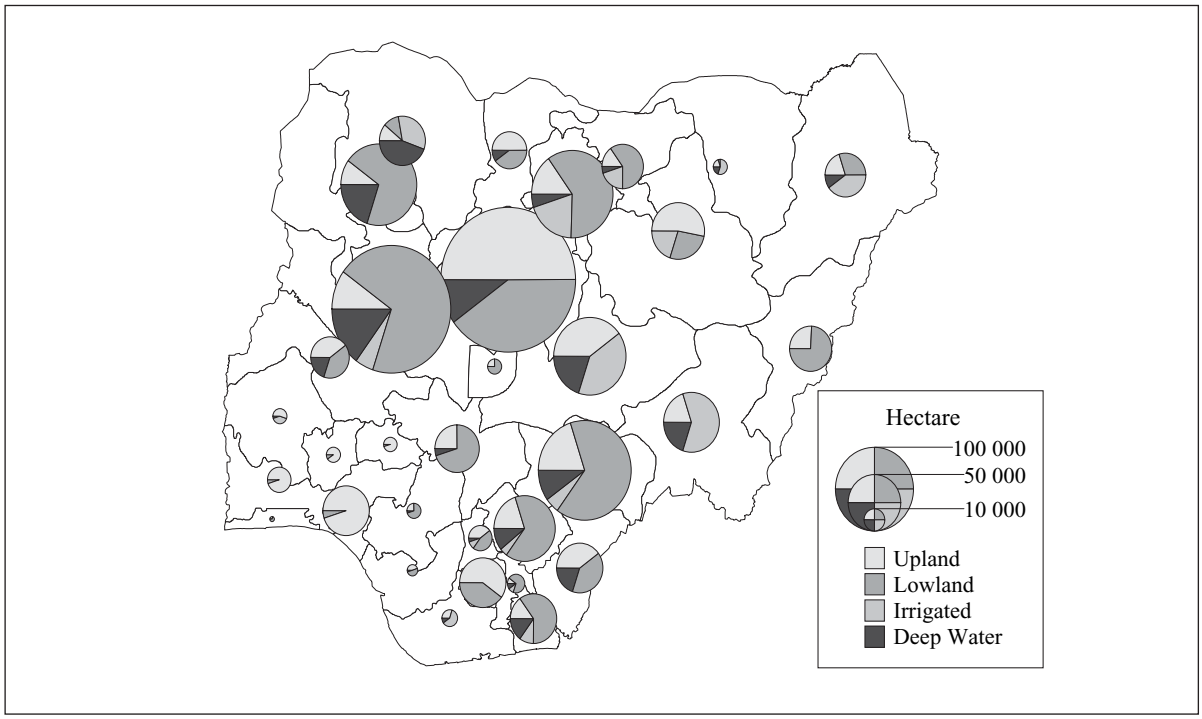
Rain fed upland rice production accounts for 30 per cent of the total rice-growing area. Under this system, rice is seeded directly in non-flooded, well-drained soil on level to steeply sloping fields. Since rain is the only source of water, this production system is generally limited to areas with more than 1,300 mm of annual rainfall. Yields are slightly higher in the south than in the north because of better rainfall in the former. The average yield for rain fed upland rice is 1.7 tons/ha.

Upland rice is typically intercropped with vegetables, maize, yam or cassava among others. The land is cleared between December and March. With the onset of the rains in early April, the land is prepared and the seeds broadcast and harrowed in with a hoe. Ofada is the traditional variety cultivated. Weeding and harvesting is usually manual.

Rain fed lowland rice is the most widespread system and accounts for approximately half of the total rice area in Nigeria. Expansion into the rain fed lowlands appears to have been a major reason for the rapid increase in paddy production in recent years[7]. Under this system rice is transplanted or seeded directly in the soil on level to slightly sloping fields with variable depth and duration of flooding depending on rainfall. This system is found mainly along the flooded river valleys such as the Niger Basin, Kaduna Basin, Benue Basin, etc. of the Northern states.

This system is also common in Abakaliki and Ogoja areas of the Ebonyi and Cross River states respectively. In most of these areas, the *fadamas*

Figure 4.4: Geographical distribution of rice-growing areas by ecology



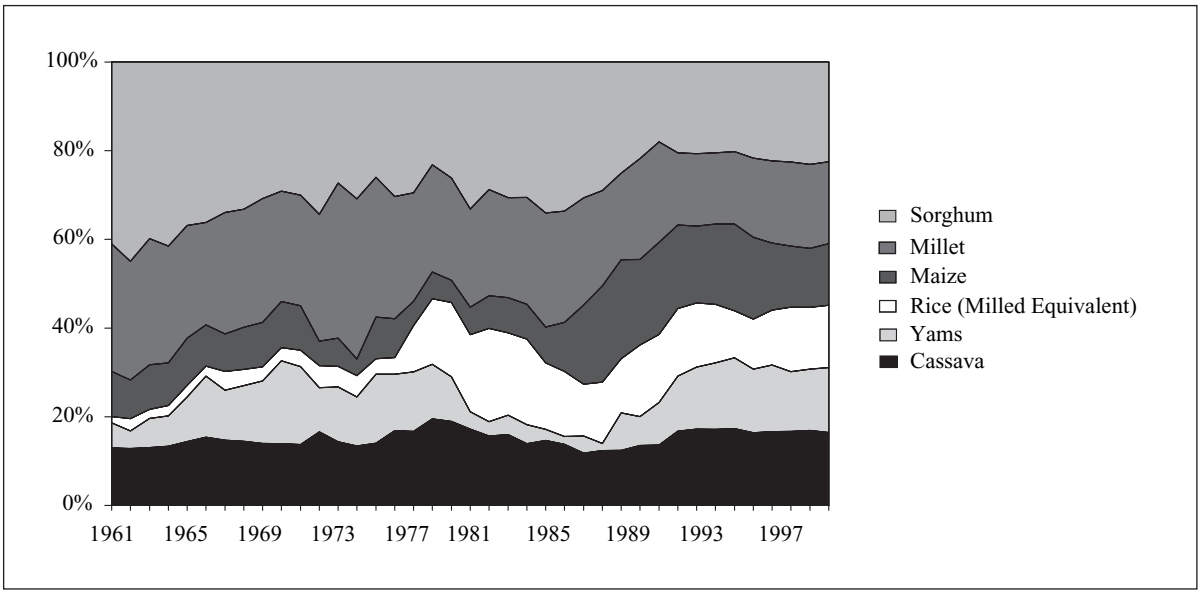
[6] Singh *et al.,* 1997.
[7] FAO, 2001.

(riverbanks) are usually flooded during the rainy season that lasts for four to five months. Only one crop is planted each year and the average yield is about 2.2 tons/ha. Fertilizer and improved seeds are now being introduced in the production system.

Irrigated rice systems account for 16 per cent of the total rice area in Nigeria (FAO data). Irrigated rice encompasses lowlands with good water control, enabling two crops per year. The yield obtained (3.5 tons/ha) is generally higher than in other systems. Irrigated rice systems include both large-scale irrigation schemes in the north and small-scale developed inland valleys in the south. Rice is the main irrigated crop in Nigeria – particularly in the main season.[8]

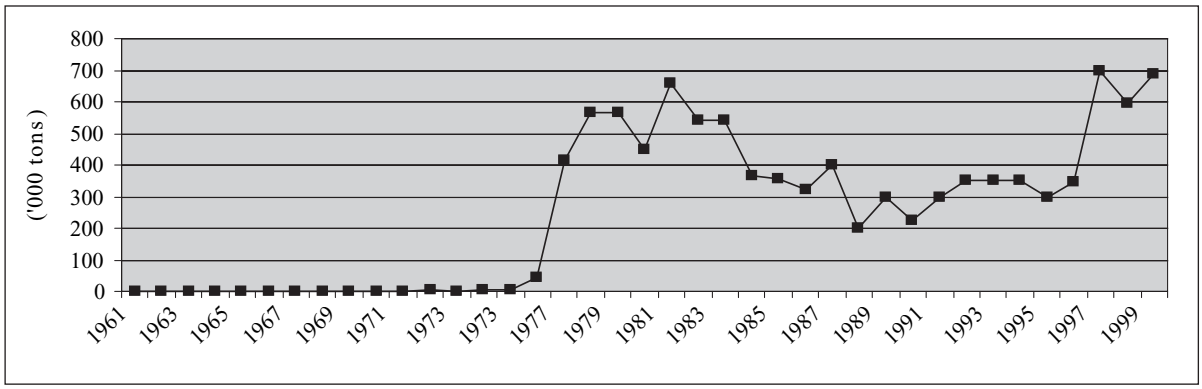
Deepwater rice growing involves flooding of 60-100 cm deep, whereas flooding in the floating rice-growing system exceeds 100 cm. Deepwater and floating rice production systems are increasingly marginalized, and area and production figures are generally limited. These production systems can be found in the Sokoto-Rima valleys and in some other flooded plains or *fadamas* where the water is deep. The mangrove swamp rice production system is found on coastal areas where the ocean inundates the land at high tide and drains away at low tide. Most mangrove swamps have a salt-free growing period during the rainy season when freshwater flooding washes the land and displaces tidal flows. Consequently, the rice-growing period is directly related to distance from the ocean, and varies from under four months in the nearest estuaries to more than six months in the more distant ones. Soils are generally more fertile than in other ecologies since they benefit from regular deposits of silt during annual flooding. However, the soils are also characterized by high salinity and sulphate acidity. Specific areas where this production system can be found include the Niger Delta, particularly in the deep-flooded areas of Ilushi, Lagos and Calabar. While this system has great potential for rice cultivation in Nigeria, high labour costs associated with clearing and potential negative environmental impacts from oil exploration activities pose major constraints to further expansion of the area.

Figure 4.5: Nigerian staple food basket



[8] Fagade, 1997; Shaib *et al.,* 1997.

Figure 4.6: Quantity of Nigeria's rice imports



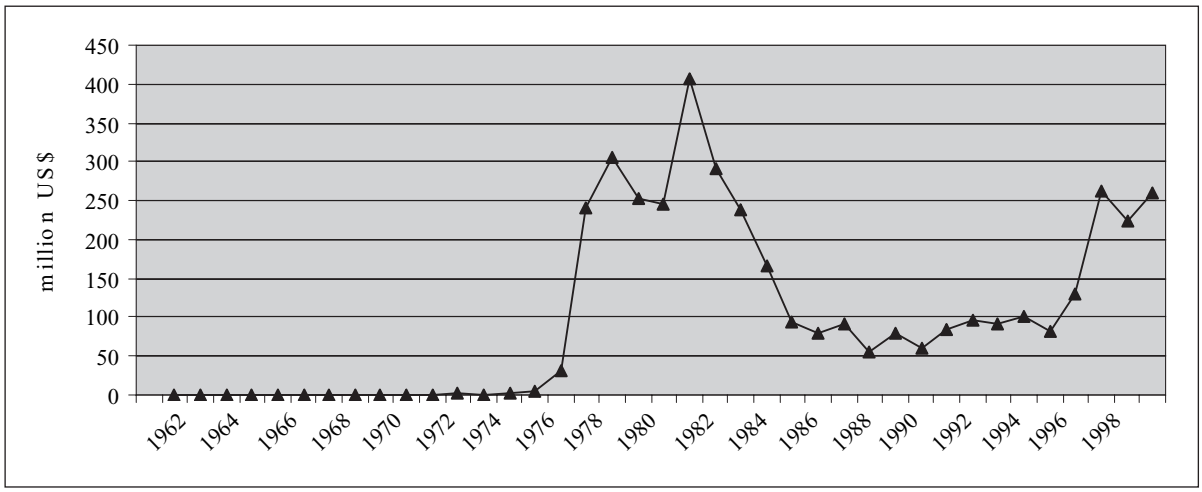
Source: FAO STAT.

4.2 Demand pattern

Demand for rice in Nigeria has been soaring over the past years, triggered by a combination of factors. According to Akanji (1995), rising demand was partly the result of population growth, increasing income levels and rapid urbanization and its associated changes in family occupational structures. As women enter the work force the opportunity cost of their time increases and convenience foods such as rice, which can be prepared quickly, gain importance. Similarly, as men work greater distances from their homes in the urban setting, more meals are consumed away from home and rice is often the preferred meal. These trends have meant that rice is no longer a luxury food; it has become a major source of calories for all strata of the urban population. The increasing visibility of rice in the staple food basket of Nigerians over the years is demonstrated in Figure 4.5.

Domestic production capacity is far below the national rice requirements[9] and Nigeria has had to fill the gap by resorting to importing milled rice. Figure 4.6 indicates the trend in Nigerian rice imports. It is observed that imports were insignificant in the 1960s and early 1970s. However, after 1977 imports increased to more than 300,000 metric tons but dropped significantly from 1985 when rice imports were banned.

Figure 4.7: Value of Nigeria's rice imports



Source: FAO STAT.

[9] Wudiri and Fatoba, 1992; and Ladebo, 1999.

Although, rice imports began to rise again in 1991, major importation did not occur until after the ban was lifted in 1995. On the whole, Nigeria's self-sufficiency profile in rice, i.e. the share of domestic production in relation to total rice consumption, has varied over the years (Table 4.3). Domestic output accounted for nearly 99 per cent of rice consumption between 1961 and 1975, but as imports increased the share of domestic production dwindled. The import expenditure over the years (see Figure 4.7) tends to follow the trend in imports. In the last few years, Nigeria spent about US$ 600 million annually on rice imports alone.

4.3 Processing

Rice processing activities essentially involve the parboiling and milling of paddy. Parboiling, which precedes milling, is often carried out using local drums that allow the preparation of a uniform final product from a mixture of paddy derived from different varieties of rice.

Traditional domestic parboiling techniques, as explained by Stuykers (1982), involve soaking the paddy in cold water for two days and then heating it in drums until the grains show signs of splitting, whereupon the rice is removed for drying. The problem lies in the long soaking when fermentation commences, and also with the very fast drying (in two hours or less) which leads to as much as 49 per cent of broken grains during milling.

There is a complete absence of modern technology for drying the parboiled paddy. Often, drying is done on the roadside, which accounts for the presence of foreign bodies such as stones in the final product. Sun drying in the open does not allow for drying during the rainy season, which also accounts for the low level of milling during that same period. Even where drying is possible during the rainy season, the paddies often do not dry properly and this partly accounts for the foul odour of the final product.

Three main milling methods were identified in Nigeria: the Traditional or Hand-pounding System, the Small Mill Processing System and the Large Mill Processing System. The hand-pounding system is a traditional practice that involves pounding parboiled and sun dried paddy in a mortar to separate the husks and bran from the grains. The last stage of this processing is the winnowing. A major disadvantage of the traditional system is that it is very slow and labour intensive. Furthermore, the final product obtained often contains a high percentage of broken grains and foreign bodies. Given these limitations, this system is fast being discarded.

Small rice mills are the most predominant of the three milling systems. They can be found in major rice processing areas such as Abakaliki in Ebonyi state, Lafia in Nasarawa state and a host of others. Discussions with rice experts revealed that about 85 per cent of Nigerian rice is processed through the small milling system, which involves the use of mechanised milling units (often operating the old cono-disc technology) with a maximum and minimum capacity of 600 and 200-300 tons per day respectively.

At the moment, most small rice mills operate at about one ton per hour. This is due to insufficient paddy for processing. Some of the millers travel far, including to other countries, to buy paddy. Generally, the final product of the small mills is superior to that processed under the traditional hand-pounding system. In some cases however, the final product contains a high percentage of broken grains and thus sells for a lower price. Another major problem with processing is the non-availability of destoning machines. Although some major rice processing areas have destoners, farmers do not commonly use these because of the small volumes they produce. The lack of destoners plus the drying of parboiled paddy by the roadside accounts for the large presence of stones in the final product.

Most of the few large mills that exist are owned by governmental or quasi-governmental parastatals such as the State Agriculture Development Projects. The Pateggi, Uzo-Awani and Agbede rice mills are typical examples of large mills in Nigeria. These

mills combine rice milling with rice polishing, and in most cases they possess separate parboiling equipment. However, large mills are not popular with the Nigerian farmers. It is also important to note that large mills require substantial capital investment and most of the existing large mills have broken down due to the lack of spare parts and inadequate maintenance.

4.4 Marketing

Rice marketing includes all the business activities in the flow of paddy and milled rice from the point of initial production until it reaches the ultimate consumers at the right time, in the right place and as conveniently as possible, with enough of a profit margin to cover the costs of the various operations along the chain.[10] From this perspective, Aderibigbe (1997) divided the marketing of local rice into four stages with a change of product ownership occurring between each stage. The stages in successive order are (i) production through harvesting, (ii) movement from the farms to processing centres, (iii) movement of the milled rice from processing areas to urban consumption centres, and finally (iv) the wholesaling and retailing in urban centres.

The marketing of locally milled rice in Nigeria has undergone three phases. During the first phase that ended in 1976, individuals undertook the marketing of locally milled rice. During the second phase, from 1977 through 1985, a limited form of Government participation in the marketing of rice and other cereals was introduced through the establishment of the Nigerian Grains Board that purchased milled and paddy rice directly from farmers and provided storage so that rice could be available on the market during non-harvest periods. In the third phase commencing in 1986, private individuals were in full charge of the marketing of locally produced rice. Associations of market men and women exist in most urban markets.

The main marketing channel for imported rice is from importers to wholesalers and retailers, and then from retailers to final consumers. The direct flow of imported rice from the importers to end-consumers is minor. Paddy rice flows mainly from the farmers to the assemblers, who are commissioned agents who purchase rice paddy from individual farmers and deliver it to the millers or processors. The processors dispatch the milled rice to the wholesalers for onward distribution to retailers who sell to the final consumers. Rice paddy also flows from the farmers directly to the manufacturers of livestock feed.

[10] Ihene, 1996.

5. Integrated assessment of trade liberalization

5.1 Economic impacts

The economic impact of rice activities in Nigeria is felt at five main levels: production, processing, marketing, food vending and external trade. The main economic impact is in respect of income and employment generation for those operating at each of these levels. This section examines income and employment in the various rice activities and determines how trade liberalization has impacted each. The premise of the analysis is that rice-production, processing and other activities have been affected differently between the period when trade was significantly restricted and the period when trade was liberalized. The main feature that marks the difference between the two periods is the elimination of the restrictive trade policies that prevailed with regard to rice imports before the introduction of the SAP in 1986 (including outright bans, quantitative restrictions and tariff impositions) and which were largely relaxed during liberalization.

5.1.1 Impact of rice production on income and employment at farm level

Several groups of individuals are involved in rice production, including farmers, wage labourers and suppliers of inputs (seeds, fertilizers, herbicides and pesticides), although the main group involved in production is the farmers. These groups derive food, income and/or employment from their involvement in rice production.

Erenstein *et al.* (2003) have shown that, on average, producers sell about 79 per cent of their total annual paddy production. The remainder is held back for their own household's consumption (about 10 per cent), seed (7 per cent) and other uses including gifts (4 per cent). This indicates that rice is mainly cultivated for income so profitability is the major economic consideration in the cultivation of rice in Nigeria.

Farm-level studies conducted at various times before and after the inception of economic liberalization provide information on the degree of profitability across rice production systems. For instance, Eremie and Akinwumi (1986) conducted a study on the profitability of irrigated rice production in three irrigation project areas in Nigeria: the South Chad Irrigation Project (SCIP), the Shonga Irrigation Scheme (SIS) and the World Bank Rice Project (WBRP) located in Borno, Kwara and Anambra States respectively. Data for the 1981 production season were used to represent the period prior to liberalization of the economy. The return on operator's labour and management was used as a measure of profitability, and the data indicates that profitability was negative in SCIP and SIS but was positive (over N 1,000) in the WBRP (Table 5.1). This implies that before liberalization rice farmers operating in SCIP or SIS could not realize the average wage rate for their labour. Although farmers under the WBRP fared much better, the return on their labour and management was below the national minimum wage of N 1,500 per annum in 1981, suggesting that in the short run rice farmers under the WBRP would have been better off taking up paid employment as labourers rather than engaging in rice production, so this group of farmers must have continued producing rice for other reasons such as a supplementary income to other activities, their

Table 5.1: Private profitability of rice production in three irrigation projects, 1981/82

	Item	SCIP	SIS	WBRP
A.	(a) farm size (ha)	1.60	2.07	2.50
	(b) Yield (tonne/ha)	0.91	1.82	2.39
	(c) Paddy price (N/tonne)	347.00	400.00	467.00
	(d) Value of output (N)	505.23	1506.96	2790.33
B.	Cost per farm			
	(a) All expenses except unpaid labour 1/	740.91	799.47	1429.33
	(b) Family labour	194.38	793.74	388.53
C.	Profitability measures			
	(a) Net income per farm 2/	-235.68	707.49	1361.00
	(b) Net income per hectare	-147.30	341.78	544.40
	(c) Return to operator's labour and management 3/	-363.80	-19.45	1165.70

Note: 1/ Total cost minus item (1);
2/ Item A(d) minus item B(a);
3/ Item C(a) plus interest expenses minus item B(b)

Source: Eremie and Akinwumi (1986).

immobility or non-income benefits such as rice for their own household's consumption. The study by Okorji and Obiechina (1985) also indicated that rice production in rain fed uplands and lowlands was only marginally profitable before liberalization.

Olagoke (1990) compared production costs, input usage and returns on irrigated, swamp and upland rice systems using 1987-88 production data. As can be expected, he found that the yield achieved under each production system and the cost of production had significant impacts on producer's total income and profitability. The highest rice yield per hectare (2.19 metric tons of paddy) was obtained from irrigated fields, followed by the swamp fields (1.96 metric tons/ha) and then upland fields (1.71 metric tons/ha). The analysis indicated that the highest total production costs were associated with irrigated rice fields as these incurred irrigation water costs and higher labour and machine-use costs than the other production systems. Because of the higher production costs of irrigated rice fields, swamp rice achieved the highest net returns of the three production systems despite slightly lower yields (Table 5.2).

Studies conducted on the liberalization period show that rice production has become even more profitable than during earlier periods. Fabisoro (2000) estimated the short-run profitability of four rice-based cropping systems: rice only, rice-melon, rice-cassava and rice-maize combinations. As can be seen from the data in Table 5.3, rice planted in combination with other crops generated a higher gross margin than rice as a sole crop. Among the intercropping systems, the rice-melon combination generated the highest gross margin.

Adedipe *et al.* (1994) studied the profitability of rice production in relation to other food crops based on rain fed production practices. The findings on major crops grown as sole crops are summarized in Table 5.4. Rice (lowland and upland) generated higher gross margins than other cereals such as maize and sorghum but seemed to produce similar gross margins to legumes (soybeans, cowpea and groundnut). However, roots and tubers appear to have given rise to better gross margins. Further analysis that considered the return per unit of investment indicated that lowland rice generated higher returns per unit of investment than maize, sorghum, soybeans, groundnut and

Table 5.2: Costs and returns per hectare in various rice production systems in Uzo-Uwani, Enugu State, South East Nigeria (1987-88)

Item		Irrigated	Swamp	Upland
Rice Output (RO)	Ton/ha N/ha	2,653	2,371	1,970
Capital Operating Inputs	Rice	105	10.3	122
	Fertilizer	73	81	62
	Machine-hire cost	308	185	212
	Irrigation cost	197		
	Other capital operating costs	101	96	71
	Total capital operating costs (TCOC)	784	466	468
Labour	Land preparation	244	298	
	Nursery	80	61	
	Planting	224	163	
	Weeding	382	285	
	Bird scaring	65	51	
	Harvesting	257	251	
	Threshing/winnowing	11	78	
	Packaging	43	32	
	Others	75	31	
	Total labour input (TLI)	1,381	1,251	
Total variable costs (TVC=TCOC+TLI)		2,165	1,717	1,640
Gross margin	(RO-TVC)	488	654	330
Fixed Costs	Depreciation	49	523	45
	Land charge	26	33	36
	Total fixed cost (TFC)	75	86	81
Total costs	(TC=TVC+TFC)	2,240	1,803	1,721
Net return	(RO-TC)	413	568	249
Production cost per kg (N/kg)		1.02	0.92	1.01

Source: Olagoke, 1991.

Table 5.3: Crop budget indicators for upland rice cropping systems (per hectare) in Ogun State, SW Nigeria 1999

	Rice Only		Rice/Melon		Rice/Cassava		Rice/Maize	
	Value	% share	Value	% share	Value	% share	Value	% share
Rice yield (t/ha)	1.25		3.40		2.87		1.04	
Revenue (N/ha)	43,302		86,796		80,120		51,324	
– Rice	43,302	100	69,442	80	58,010	72	31,980	62
– Inter-crop			17,354	20	22,110	28	19,344	38
Variable cost (N/ha)								
– Fertilizer	605	3	-	-	459	1	113	1
– Agro-chemicals	76	0	-	-	289	1	-	-
– Planting material	1,595	9	1,170	7	2,879	9	1,297	10
– Family labour	8,156	45	2,355	15	13,416	41	5,814	46
– Hired labour	6,150	34	10,618	66	13,376	41	4,529	36
– Land	1,426	8	1,855	12	2,362	7	866	6
Total Variable Cost	17,990	100	15,998	100	32,782	100	12,618	100
Gross margin (N/ha)	25,312		70,798		47,339		38,706	
Number of cases (n)	133		4		17		8	

Source: (Fabusoro, 2000).

yam. Only cowpea and cassava generated higher returns per unit of investment than rice. The major factor was the rise in the cost of fertilizer, which was more significant for rice and thus involved higher production costs than for other crops.

Studies on the profitability of crops produced under irrigation systems in Kano State in the Sudan Savannah region of Nigeria showed that rice generated the highest benefits among the staple crops (Table 5.5). However, sugarcane and garlic gave rise to even greater benefits than rice as their yields were higher and these special crops commanded much higher market prices than rice.

Against the background of these earlier studies on the profitability of rice production among different groups of producers, the present study also involved a major survey which attempted to characterize rice producers and farm practices as well as the configuration of profitability based on the analysis of costs and returns at both the national and zone levels. The findings are discussed below.

Socio-economic characteristics of rice farmers

The socio-economic characteristics of rice farmers covered in the survey are presented in Table 5.6. As can be seen, the majority of the respondents are male. In Benue, the ratio of male to female respondents is 61:39. There were no female respondents in Niger since rice cultivation in that zone is an exclusively male activity. In Ekiti, the ratio of male to female respondents is 80:20. On the average, about 80 per cent of respondents were male. Although producing rice was not the primary occupation of all the respondents, they all engaged in some level of rice farming activities. In Benue, rice production was the primary occupation for about 37 per cent of the respondents, while about 21 percent were engaged in civil service, 13 per cent in commerce and the rest in other activities such as livestock production. In Niger and Ekiti 82 and 70 per cent of the respondents produced rice as their primary occupation respectively.

Table 5.4: Profitability of rice and other crops grown as sole crops in the Central Zone of Nigeria (1996)

Crops	Input: Variable Cost (N)									
	1 Seed	2 Fertilizer	3 Chemicals	4 Labour	5 Total Variable Cost (N)	6 Yield (tons/ha)	7 Price (N/ton)	8 Gross return (N) (6x7)	9 Gross Margin/ha (8-5) (N)	10 Return/N invested (9/5) (N)
Cereals										
1. Rice (Upland)	800	1575	5000	7500	14,875	1.5	12000	18000	3125	0.21
2. Rice (Lowland)	500	2000	5000	8900	16,400	2.0	12000	24000	7600	0.46
3. Maize	500	1200	500	7700	9,900	1.5	8000	12000	2100	0.21
4. Sorghum	200	600		2700	3,500	0.7	6000	4200	700	0.20
Legumes										
5. Soybeans	400	600	1000	6800	8,800	1.0	12000	12000	3200	0.26
6. Cowpea	450	750	2000	8100	11,300	0.6	30000	18000	6700	0.60
7. Groundnut	1500	600	100	7100	9,300	0.9	13000	11700	2400	0.26
Roots and tubers										
8. Cassava	750	600		11800	13,150	16.0	1000	22000	8850	0.67
9. Yam	30000	600		32000	63,400	12.0	6000	72000	8600	0.14

Note: Price based on Mid-1994 costs and prices. 1994 Exchange rate N52.28/US$

Source: Adedipe *et al.,* 1996.

Table 5.5: Cost and benefit of irrigated crops in Kano State, Nigeria, during the 1992/93 dry season

Crop	Yield/ha	1993 Market price (N)	Total Income (N/ha)	Cost of Production (N/ha)	Benefit (N/ha)
Wheat	2,500kg	700/100kg	17500	9535	7765
Rice (Paddy)	6000	600/100kg	36000	14860	21140
	60,000				
Maize (Green cobs)	Cobs	0.4/cob	24000	12560	11440
Tomato	200 baskets	120/basket	24000	15180	8820
Onion	150 bags	150 bag	22500	14780	7720
Sugarcane	50 tons	1,000/ton	50000	23660	26340
Pepper	200 baskets	120/basket	24000	13580	10420
Garlic	25 baskets	1800/basket	45000	18830	26170

Source: KNARDA Technical Handbook for Fadama Programme as cited in (Adedipe *et al.,* 1996).

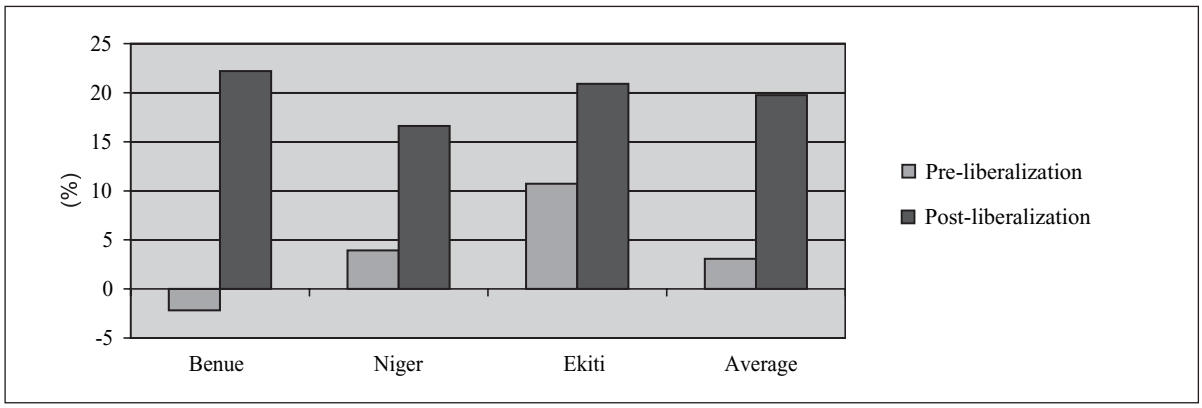
Respondents were not necessarily all household heads, but they were those involved in the rice farming activities of the specific household being interviewed. Table 5.6 shows that household heads account for 63 per cent of the respondents in Benue state and 100 and 80 per cent in Niger and Ekiti respectively, so an overall average of 81 per cent of the respondents were household heads. This distribution helps to ensure that the information gathered from the field is relatively reliable and authentic since the household heads are the major decision-makers and managers in rice-growing activities.

Table 5.6: Socio-economic characteristics of rice production respondents

Characteristics		Benue	Niger	Ekiti	Average
		Frequencies (%)			
(a) Sex					
	1. Male	61.0	100.0	80.0	80.4
	2. Female	39.0	-	20.0	19.6
(b)	Primary Occupation:				
	1. Rice production	37.4	82.5	68.7	69.4
	2. Rice processing	0.9	7.1	2.4	4.8
	3. Other crop-production	4.7	4.1	2.4	3.9
	4. Raising of livestock	4.7	0.4	-	1.3
	5. Civil service	20.6	0.7	2.4	5.7
	6. Others	31.7	5.1	24.0	14.9
(c)	Relationship to household head:				
	Household head	63.2	100.0	80.0	80.9
	Spouse	26.3	-	13.8	13.5
	Child	8.8	-	6.2	5.1
	Others	1.8	-	-	0.6
(d)	Age	48	48	47	47
(e)	Level of education:				
	None	20.0	51.9	25.8	34.8
	Primary	8.0	18.6	12.9	14.2
	Secondary	60.0	7.4	58.0	37.6
	Tertiary	12.0	-	-	2.1
	Koranic	-	25.9	3.2	11.3

Source: Survey data, 2002.

Figure 5.1: Growth in the area cultivated with rice at agro-ecological levels



Source: Survey data, 2002

The average age of respondents in Benue and Niger is 48 years, and 47 years in Ekiti. The average for all three zones is 47 years. Education and literacy can enhance farmers' decision-making and understanding capacities, for example in terms of the implications of using agro-chemicals in rice farming. As can be seen from Table 5.6, in Benue 68 per cent of the respondents were educated up to secondary level but 20 per cent had no formal education at all. In the state of Niger, half of the farmers had no education while 26 per cent had Koranic education. In Ekiti, 26 percent had no education and about 40 percent had secondary level education. Overall, about 65 percent of the respondents had some level of education while the rest had no formal education at all.

When compared to other crop farmers, however, it is observed that rice farmers are relatively more educated. The *NISER Annual Survey of Crop Production Conditions in Nigeria, 2000* indicates that only about 50.65 per cent of Nigerian crop farmers have some form of Western education. Education tends to promote the adoption of technological innovations and the ability to follow instructions on how to apply improved practices, so it can be expected that literate farmers are more innovative than illiterate ones.

Farm size

It is anticipated that trade liberalization and changes in resource use will stimulate increased rice production. For example, increasing the area cultivated could boost rice output, and increasing the use of agro-chemicals such as fertilizer, herbicides and insecticides should enhance yield and output. However the use of these agro-chemicals also has significant negative impacts on the ecosystem.

Figure 5.1 gives an indication of changes in farm area before and after trade liberalization. Before trade liberalization there was negative growth in the rice-growing area in Benue but positive growth in both Niger and Ekiti. Since trade liberalization, however, there has been a substantial increase in the rice-growing area in all three zones, from -2.18 percent before liberalization to 22.2 per cent after liberalization in Benue, from 3.92 to 16.6 per cent in Niger and 10.73 to 20.9 per cent in Ekiti. On average, the growth in all three states increased from 3.07 percent before liberalization to 19.74 per cent after liberalization, which represents an approximately six-fold increase.

The extensification process has significant implications for the environment, particularly the possibility of encroaching on important conservation areas like national parks and protected areas. However, field observations and further enquiries indicate that the new areas being brought under rice cultivation are essentially previously cultivated farmlands, *fadamas* and other lowland and upland areas. The cultivation of rice or other crops in important conservation areas is never allowed.

Table 5.7: Use of agro-chemicals in 2002

Item	Niger	Benue	Ekiti
Fertilizer use (kg/ha)	178	49.8	-
Pesticides use (litres/ha)	-	1.51	-
Herbicides use (litres/ha)	1.42	-	-

Source: Survey data, 2002.

Use of agro-chemicals on rice farms

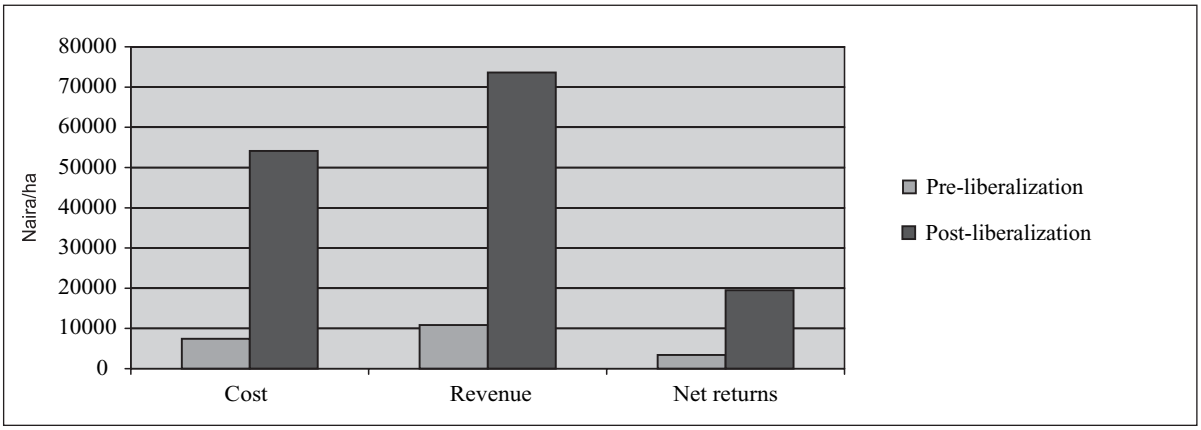
The use of agro-chemicals is particularly important in Nigerian agriculture given the continuous cultivation of the same piece of land that has led to the depletion of soil fertility. However, in the absence of reliable statistics on the consumption of agro-chemicals in the different agro-ecologies before trade liberalization, the analysis is limited to examining the adequacy or otherwise of the level of consumption of agro-chemicals after liberalization.

Table 5.7 shows that the use of agro-chemicals on the average farm, irrespective of agro-ecologies, is in fact minimal. For example, the levels of fertilizer consumption in Niger and Benue States were only 178 and 50 kg/ha respectively, while in Ekiti none of the rice farmers surveyed used fertilizer. The current level of chemical usage is certainly low when compared with the average fertilizer consumption level per hectare in Nigeria (6000 kg/ha in 2000) (WDI, 2002). Benue was the only zone that reported using pesticides even though pests constitute a major menace on rice farms. The level of pesticide consumption in the state was only 1.51 litres/ha. Niger reported using about 1.42 litres/ha of herbicides to control weeds. Presumably the high cost of chemicals and the general non-availability of inputs is one of the major reasons for their low consumption in these ecologies.

Cost and return analysis at the national level

Figure 5.2 presents the cost and return profile of one hectare of rice farm in Nigeria before and after trade liberalization. The figure shows that the aggregate cost of production increased from N 7,452 before liberalization to N 54,125 after liberalization (an increase of about 626 percent). An analysis of the cost components indicates that labour constituted the highest cost item, representing 61 and 78 percent of the aggregate costs before and after trade liberalization respectively. Expenditure on fertilizer and seeds

Figure 5.2: Costs and returns in rice production (national average)



Source: Survey data, 2002

increased by 415 and 855 per cent respectively; expenditure on insecticides and herbicides declined by 4 and 47 per cent respectively. The substantial increase in the aggregate cost profile of rice farming could be attributed to increases in the prices of agricultural inputs occasioned by the liberalization itself. Akinyosoye *et al.* (1998) showed that the prices of agricultural inputs rose significantly after liberalization. For example, fertilizer prices rose by more than 800 per cent while wage rates increased by more than 233 per cent.

Returns are conditioned by the physical output and the price obtained for the output. Analysis shows that the rice output per hectare declined from 2.53 tons pre-liberalization to 2.23 tons post-liberalization. However, the returns per hectare rose from N 10,840 before liberalization to N 73,590 after liberalization as a result of the substantial rise in the nominal price of rice from N 5,333/ton pre-liberalization to N 33,000/ton post-liberalization.

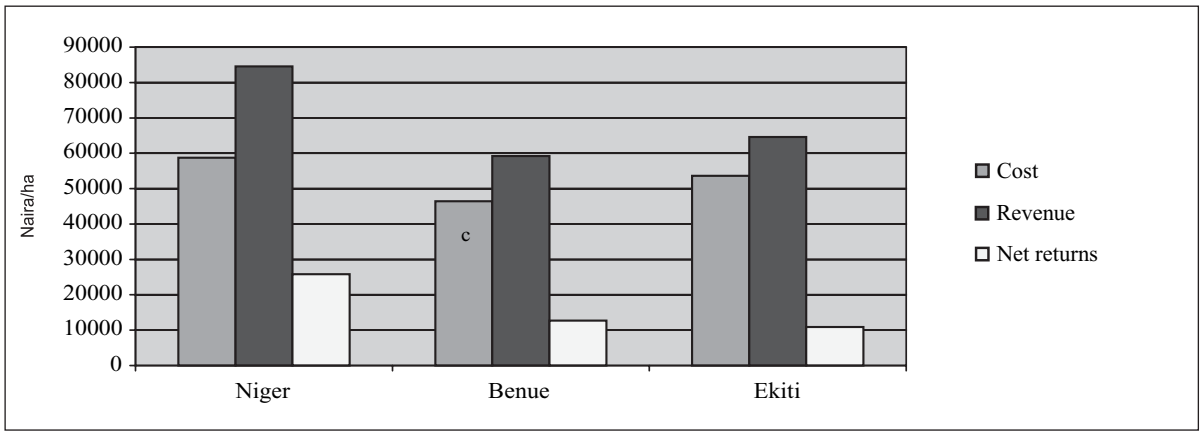
The gross margin analysis, which considers the difference between costs and returns, indicates that the net returns from one hectare of rice farm increased from N 3,388 before liberalization to N 19,465 after liberalization. The real gross margin obtained by deflating it with the corresponding consumer price index indicates a value of N 33.9 per hectare before liberalization and N 24.5 per hectare after liberalization. This seems to indicate that rice farmers realized much higher returns on their farm investments prior to trade liberalization. However, smallholder farmers generally base their investment decisions on nominal rather than real income. They may therefore consider their farm income from rice as being much higher since trade liberalization and consequently expand their cultivation of rice.

In summary, the analysis of the costs and returns shows that trade liberalization has engendered a substantial increase in the cost and return profiles of the average rice farmer, not because of any significant increase in physical output but rather as a result of a significant increase in the nominal price of rice. However, although net returns increased after liberalization, rice production was more profitable before trade liberalization.

Costs and returns at agro-ecological levels

The costs and returns of rice farming vary across agro-ecological zones and systems. Attempt was made to capture the level of profitability of rice production in these zones. However, in the absence of reliable data for earlier periods, this analysis was conducted for the 2002 crop season only. Figure 5.3 shows that production costs were highest in Niger, followed by Ekiti and Benue. Labour accounts for the highest share of production costs in all three zones (Table 5.8). Yield is highest in Niger (2.82 metric tons/ha), followed by Benue

Figure 5.3: Costs and returns in rice production by agro-ecologies



Source: Survey data, 2002

Table 5.8: Estimated cost and returns at the agro-ecological level

Items	Niger	Benue	Ekiti
Costs (N)			
Labour	46847	34895	47786
Catapults	648	-	330
Fertilizer	4716	2853	-
Rice seedlings	2054	4199	2613
Pesticides	1448	-	1112
Herbicides	1260	-	614
Depreciation	1775	4529	1212
Total Cost	**58748**	**46475**	**53668**
Revenue (N)			
Output (tons)	2.82	1.64	1.50
Total revenue	**84528**	**59194**	**64575**
Gross margin (N)	25780	12719	10907
Profitability ratio	0.44	0.27	0.20

Sources: Field survey, 2002.

(1.64 metric tons/ha) and Ekiti (1.5 metric tons/ha). The high output in Niger State is explained by the use of fertilizer, insecticides and herbicides, as in Benue where rice is cultivated using a similar system (swamp). The low production in Ekiti is not surprising since farmers in that zone do not employ fertilizers, and upland rice, which predominates in the area, usually records inferior yields compared to other production systems. Net returns and profitability are highest in Niger, followed by Benue and Ekiti. These findings indicate that rice cultivation has been profitable under different ecologies after trade liberalization.

5.1.2 Impact of rice processing on income and employment

Rice processing is a distinct activity that involves the removal of the panicles from the rice seed to obtain a grain suitable for cooking. Other rice processing activities include parboiling, drying and milling. These activities may be performed by the farmer or contracted out to millers who operate

Table 5.9: Socio-economic characteristics of rice processing respondents

Characteristics	Benue	Niger	Ekiti	Average
Sex (%)				
1. Male	71.0	98.0	90.0	5.0
2. Female	29.0	2.0	10.0	13.7
Primary Occupation (%)				
1. Rice production	2.5	84.8	17.9	35.1
2. Rice processing	92.5	13.6	35.7	47.3
3. Production of other crops	5.0	-	7.1	6.1
4. Civil service			3.6	3.6
5. Rice marketing			14.3	14.3
6. Others			21.5	11.5
Age (years)	35	45	40	40.0
Level of educational attainment (%)				
Primary	40.0	70.0	23.4	44.5
Secondary	50.0	-	66.2	58.1
Tertiary	10.0	-	2.6	6.3
Koranic	-	30.0	7.8	18.9

Source: Survey data, 2002.

milling machines in rice producing communities around the country. Rice processing is thus an occupation that provides income and employment.

Socio-economic characteristics of rice processors

The socio-economic characteristics of the processors as presented in Table 5.9 reveal that the majority of processors are male. In Benue, the ratio of male to female respondents is 71:29. In Niger, the ratio is 98:2 and in Ekiti 90:10. The table also shows that in Benue, the primary occupation of about 93 per cent of the respondents is rice processing while the remainder are also engaged in rice production (2.5 per cent) and the production of other crops (5 per cent). In Niger, rice production is the primary occupation for about 85 per cent of the respondents but the latter carried out processing activities as well. Only about 14 per cent are engaged solely in processing. In Ekiti, about 36 per cent of the respondents are rice millers while about 18 per cent are also producers. A significant proportion of the respondents is engaged in commerce (about 18 per cent) and rice marketing (14 per cent). The education level of the respondents differs from one zone to another. In Benue, 50 per cent were educated to secondary level and 40 per cent to just primary level. In Niger, the majority of the respondents (70 per cent) had only been educated to primary level while the remaining 30 per cent had received the Koranic form of education. For Ekiti, 66 per cent of the respondents had secondary level education and 23 per cent had only reached primary level. The average age of the respondents in Benue, Niger and Ekiti is 35 years, 45 years and 40 years respectively.

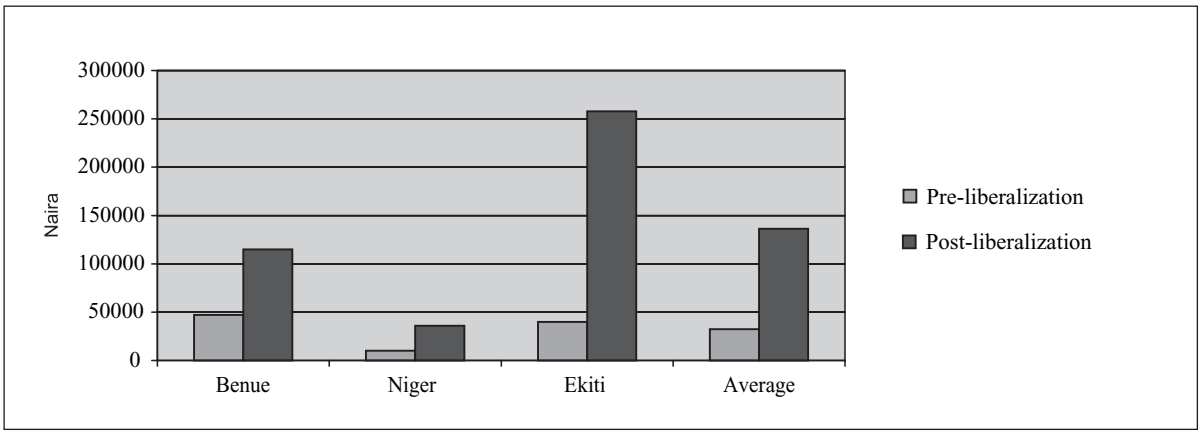
Income effect

Figure 5.4 shows an enormous increase in income from rice processing after trade liberalization in the various agro-ecological zones. Income from rice processing increased from N 47,150 to N 115,000 in Benue, from N 10,000 to N 35,900 in Niger and from N 39,800 to N 257,700 in Ekiti. All zones confounded, the average income from rice processing rose from N 32,316 before liberalization to N 136,200 after liberalization.

Employment effects

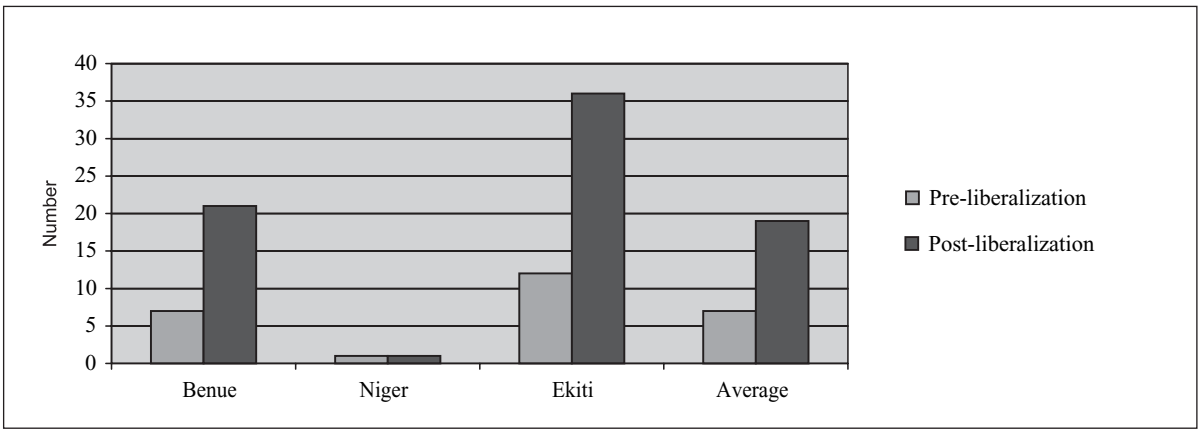
Figure 5.5 shows that before trade liberalization the typical rice-processing mill in the study area had only 7 employees in Benue, 1 in Niger and 12 in Ekiti. However, after trade liberalization, the number of labourers employed by the mills increased to 21 in Benue and 36 in Ekiti. In Niger the number remained constant. Across all three areas, the number of labourers increased from an average of 7 labourers per mill before trade liberalization to and average of 19 after liberalization. It could be concluded from these observations that trade liberalization has led to the creation of more jobs in the rice-processing sub-sector.

Figure 5.4: Income from processing before and after trade liberalization



Source: Survey data, 2002

Figure 5.5: Employees per mill before and after trade liberalization



Source: Survey data, 2002

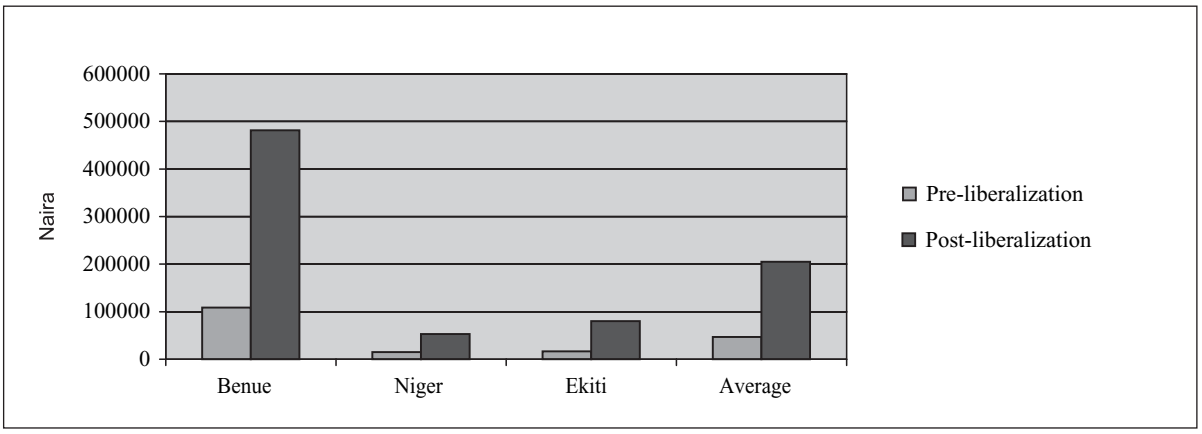
5.1.3 Impact of rice marketing on income and employment

Rice marketing is a major source of income for those involved in this sub-sector. Rice marketing in Nigeria can be classified into two broad systems based on the original source of the rice supply, namely (i) marketing of locally produced rice and (ii) marketing of imported rice. However, this study is concerned mainly with the marketing of locally produced rice. Figure 5.7 indicates that the level of income derived from the marketing of local rice in the areas covered in the study increased after trade liberalization in all three agro-ecological zones. Income from rice marketing in Benue increased fourfold from N 108,600 to N 481,600. In Niger it increased from N 15,300 to N 53,000 and in Ekiti from N 16,500 to N 80,000. On average, income from rice marketing rose from N 46,800 before trade liberalization to N 204,866 after trade liberalization. This huge increase in income from rice marketing is indicative of greater commercialisation of rice since liberalization. However, it should be noted that the cost component of rice marketing has not been taken into consideration. The conclusion from this analysis is that trade liberalization has increased the gross income of rice marketers, who are clear winners and major beneficiaries of trade liberalization policies.

Food vending and restaurants

Rice is a major item on the menus of food vendors and restaurants selling cooked food. Food vendors

Figure 5.6: Income from rice marketing before and after trade liberalization



Source: Survey data

operating single-person enterprises are numerous in towns and cities, serving the working class in Government offices, private institutions and other operators in informal sectors. Cooked rice served on its own or in combination with other foods such as fried plantain and cooked beans generates considerable income for the operators of these food outlets. Waged employment is also guaranteed to additional hands hired by food vending operators. Thus food vendors and restaurant owners should also be regarded as winners.

External trade sector

Over the years large-scale rice imports have provided employment and trading opportunities for several firms and hoards of wholesalers and distributors across the country. Participants also include transporters, daily paid workers and various categories of service providers in the rice business. These are the people involved in the over US$ 1 billion a year rice import business. Local production is aimed at eliminating these imports and conserving foreign exchange for other development purposes.

5.2. Social impacts

5.2.1 Social impact assessment

The premise of the social impact analysis of the Nigerian rice sector is based on the changes within the production system occasioned by trade liberalization policies. Earlier studies in different countries on the general theme of integrated assessment of the impact of trade liberalization policies, especially the direct effects of WTO agreements, made use of a variety of methods to assess the social impacts of liberalization measures. These methods tend to focus on the possible outcomes of the interaction of production and the natural environment on the lives of the producers and non-producers in a given production system. Perspectives of such analyses range from effects on employment or labour opportunities (in Argentina and Ecuador), migration and health impacts as well as institutional development (in Tanzania), structural transformation and land use effects (in China) and price effects and other market performance criteria (in Senegal). In Nigeria, the cocoa sector, gender equity issues and impacts on health and education were assessed.

Therefore, the social impact assessment of this study aims to determine how the quality of life of those involved in rice production has been affected directly and indirectly by trade liberalization. To do so a number of analytical and inferential tools are used.

The social well being of rice-farming households and communities was compared with the national situation, focusing on quality-of-life indicators such as employment, literacy, health, social cohesion and sustainable livelihoods. The indicators include the literacy rate (as shown by primary and secondary school enrolment), rural unemployment rates as a measure of employment effects, disease prevalence, and social cohesion as measured by migration patterns and the formation of social institutions for promoting the interests of rice entrepreneurs. If the indicators in the rice producing states show a different pattern from the national indices, then the rice economy is seen to have had a positive or negative impact as the case may be.

Structural transformation effects are assessed by looking at the rate of market development, farmers' production objectives, the structure of household income and expenditure, and land and labour use changes resulting from increasing commercialisation. Gender equity is assessed via the comparative pattern of participation and other coping strategies of male and female rice farmers. A sustainable livelihood approach is implied in the poverty analysis using indicators such as household income and expenditure patterns, poverty incidence as well as the role of communities in managing poverty via the development of rice enterprises. A social valuation scenario is discussed, which can guide a net social cost-benefit analysis based on some of the major socio-economic changes.

Secondary data was analysed to compare the trends in national quality-of-life indicators with those obtained from the three rice-producing regions selected for this study. In addition, participatory

methodologies were employed and Focus Group Discussions (FGD) were conducted from a gender perspective in the rural rice farming community and the semi-urban rice processing communities. This is expected to reveal the community perspectives with respect to life-pattern changes; especially social cohesion factors that have accompanied increased rice production in the years of trade liberalization. The main findings are discussed below.

Rice as food in farming households

In FGD responses farmers indicated that, apart from cash from rice sales, they depend heavily on rice for home consumption. The cultivation of other crops also remains an important goal "…to meet food needs of the family in case rice does not do well ...; we can always harvest cassava and yam and we will not starve …". While preference for rice as a staple meal is generally on the increase nationally, it would appear that the expanded local output is geared partly towards meeting the increased household consumption needs of the rice farming households and their immediate rural communities where the consumption orientation is changing. In the more metropolitan areas consumer behaviour appears to have altered, with quality rather than availability being a basis for choosing rice.

Employment

The survey revealed that an increasing number of people are engaging in rice farming. People even migrate from towns to villages for the purpose of producing rice. Youths are finding employment in both rice farming and processing. Survey results indicate that some of the rice producers in Igbimo areas of Ekiti State and Abakaliki areas of Abia State were migrants from other parts of the two states. FGDs revealed that in Benue state, most of the newly installed processing and milling machines were bought by educated youths who did not find employment in the cities. Non-rice farmers are also engaged in providing casual labour for parboiling, shelling, winnowing, bagging, loading and transporting rice. According to the interview responses "…. it is the idle people that we engage to do things like blowing and helping to parboil, because we farmers usually parboil our rice before selling. It yields more money but also needs a lot of hands." Rice farmers do not usually market beyond the village level or farm gate. Marketers buy paddy for parboiling and processing, and then market the processed rice. Thus, rice generates employment at different levels; parboiling creates employment at the village level, and other aspects of processing create employment in urban areas.

Aggregate data for the nation and the states (Table 5.10) point to the fact that (rural) unemployment dropped between 1992 and 1995 but then rose again. This is closely related to the governance structure of the 1992-1995 period and the generally depressed state of the national economy. However, in the rice sector, primary survey data indicate that the rice sector provided a more positive effect in the form of gainful employment and wage

Table 5.10: Pattern of employment in rice producing states (rural unemployment rate)

Year	National	Niger	Benue	Ondo/Ekiti
1992	3.2	1.9	2.7	5.1
1993	2.5	2.2	1.3	1.0
1994	1.7	-	-	-
1995	1.6	0.3	0.3	0.4
1996	2.8	1.0	0.7	0.9
1998	2.9	1.0	0.5	0.7

Source: FOS (1999): National Integrated Survey of Households.

increases compared to the formal sector. Wages have increased for all categories of workers in the processing sector, ranging from a growth rate of 16 per cent in Benue to about 88 per cent in Ekiti. Indeed, wage increases in Ekiti are closer to wage increases in the formal sector especially between 1995 and 2000, when wages increased by over 100 per cent for all categories of workers.

Education

Rice income is used primarily to pay for children's school fees, especially where women rice farmers are concerned. This is clearly indicated in the FGD responses, especially those of females. In addition to taking care of many needs from rice income "…you get money to pay fees, sew uniforms, buy sandals… It has enabled our children to go ahead with their schooling. That is progress," claimed the rice farmers in Aliade.

Secondary data indicate that the primary-school enrolment rate in the country surged in 1986 as a result of favourable national policy changes. Although the rate of enrolment dropped marginally in 1990, all three rice-producing states experienced positive growth rates in school enrolment over the same period, except Ekiti where secondary school enrolment fell marginally. The creation of wealth in rice centres has had a positive effect on the education of children. Consequently, the literacy rate within rice-farming households is higher than overall average rural literacy rates for these states, especially in Ekiti and Niger where over 60 and 40 per cent respectively of rice-producing households are literate.

Social interaction and cohesion

According to the FGD responses, "the rice-processing season is always a happy season. Many people come into the village for the processing. There are also many sellers from other states. As long as there is rice in the machines, people will always come". Respondents also state, "Many youths have come back from the cities to claim land for rice farming, some forcefully." Because of the awareness of the high profitability of growing rice compared to other crops, more people are being attracted back into the villages from the cities. This return-migration is a positive development for urban decongestion. Rice selling brings many enlightened people to the villages and the local people improve their knowledge from such interaction. As such, the rice economy promotes national integration, awareness and modernization of the villages. A participant of the women's FGD group claimed, "Now I have many friends from the cities… We learn to speak English because of mixing with them."

Institutional development

Institutional support from the public sector should enhance the social impact of the rice economy by

Table 5.11: Disease prevalence patterns in rice producing states - mean annual growth rate, 1990 – 1998 (%)

Disease	National	Niger	Benue	Ondo/Ekiti
Guinea worm	-0.016	-0.92	0.87*	-0.99
Filariasis	0.17	-0.65	3.33*	-
Malaria	0.12	0.08	1.63*	-0.04
Pneumonia	1.19	0.39	2.56*	0.64
Tetanus	0.48	-0.21	-	-0.43
Tuberculosis	0.22	9.71	1.24	1.56
Typhoid	0.68	2.16	-	0.38
Diarrhoea	2.39	0.72	0.32	1.22
Schistosonusis	0.14	0.79	2.85*	-0.87

* Disease prevalence higher than the national average

Source: Computed from FOS (1998): Annual Abstracts of Statistics.

creating avenues for higher productivity and profitability and more positive income effects, poverty reduction and so on. In the absence of such Government support in most rural places in Nigeria, trade liberalization has fostered private individual and communal interests in the rice-growing areas. As revealed in the semi-structured interviews, cooperative associations have multiplied over the past 10 years, mainly to provide sustainable options for access to production resources, processing equipment, marketing loans and market development generally. For instance, bulk transportation of paddy to processing centres and of processed rice from villages to town markets has developed. The cooperative ownership of milling plants has also developed. Thus, while about 95 per cent of rice farmers claim that no formal institutional support exists in the producing areas, all of the respondents in Ekiti State and 65 per cent in Benue belong to cooperatives or other trade groups. There are many Government-supported projects for rice production in several of the Northern States, mainly irrigation schemes. For instance, Niger and Kaduna States are the only states where irrigation is still used substantially to produce rice in Nigeria. Overall, liberalization has strengthened private institutions.

Health effects

Rice farming, processing and marketing has reduced poverty and improved the overall quality of life in producing communities. However, certain diseases are associated with swamp rice production. Without boots, worms enter the skin and cause ill health. Due to hours of bending in the swamp fields, waist pain is a serious health concern. During processing, respiratory-tract infections are especially common. Women suffer respiratory infections when winnowing. Similarly, it has been noticed that chest pain associated with inhaling the smoke from parboiling is on the increase as a result of the expansion in rice production activities.

Secondary data on disease prevalence in the producing states indicate that in Benue State, where swamp rice is common, the prevalence of diseases associated with swampy conditions such as guinea worm, filariasis, etc is higher than the national average (see Table 5.11). However, the prevalence of these diseases is lower than the national average in Ekiti and Niger States. Diseases usually associated with poverty, especially tuberculosis, are higher than the national average in all three states. Typhoid and diarrhea, which are associated with poor living conditions, appear to be more controlled, perhaps due to better nutrition. Participants in the FGD stated, "There is food to eat from rice." "We are able to survive famine periods because when you grow rice, your family will be well fed".

Gender factors

There are marked gender differences in terms of participation in rice production activities. For instance, dry-land farming in Benue State is predominantly the domain of men, with women assisting mainly in weeding and sometimes harvesting. Female farmers are only so 'de jure' and not 'de facto', i.e. women own farms but the latter are managed by helpers, usually their children and hired labour. Female labour is only used for specific tasks. Swamp rice is, however, farmed by both men and women. There is, therefore, a strong presence of female rice farmers in Benue state while labour patterns show an equal participation ratio of male household heads and wives. According to male FGD respondents, male farmers always require the input of females for certain tasks: "If you have no wife to help you in rice farming, you will suffer." Female farmers, on the other hand, resort to using paid male labour for tedious tasks while the male farmers depend more on female family members. In the dry-land farming region, women's rice enterprises still depend on 'helpers'. One of the female respondents explained "My children farm rice for me and I depend on their help."

In dry-land systems, the level of technology also varies by gender. While men patronize and depend on modern processing centres, women still do most of their parboiling 'at home' with help from other family members. In the swamp rice region, both men and women depend on modern machines for processing. There is a comparable level of control of 'own farms' by male and female rice farmers

with respect to farm decisions, marketing options and use of rice income.

In the past, rice farming was a family business. Now, more people have their own separate farms so family members are insufficient to meet labour needs. "Both men and women get jobs during the rice season," the respondents stated.

Sustainable livelihood (poverty incidence) from regional and household perspectives

The question here is whether the income derived from rice production has translated into more sustainable livelihoods or poverty reduction in the rice sector. To make an informed judgement on this, the secondary data on poverty indicators such as income and expenditure patterns in the study areas were compared with the national aggregate data as analysed by the FOS. The FOS data showed that nominal income actually fell both nationally and in the three states over the pre and post liberalization periods (1980-1985 and 1992-1996 respectively). Accordingly, the average national household expenditure dropped only minimally from N 7,699.17 to N 6,448.75. In the state of Niger the mean total expenditure rose from N 6,237.69 to N 7,289.50, but in the other two states it dropped quite perceptibly. More symbolically, a positive effect can be surmised in the pattern of income and expenditure. The ratio of food to non-food expenditure actually fell in the rice producing states while the same value rose nationally (Table 5.12). This indicates a higher reliance on the cash economy and is a sign of increasing commercialisation of agriculture.

While the above indicators should imply a reduction in poverty, other indicators fail to support such a conclusion. Available evidence indicates that the incidence of poverty rose nationally from 37.8 to 54.2 per cent during the 1980s and 1990s (see Table 5.13). In the rice-producing states, the same pattern is observed. The incidence of poverty has risen faster in Ekiti than in the rest of the country. The implication is that, although increased economic activity in the rice sector has contributed to the

Table 5.12: Pattern of household expenditure (ratio of food to non-food expenditure)

Year	National	Niger	Benue	Ondo/Ekiti
1980	1.73	2.75	1.47	1.21
1985	2.85	4.30	2.71	1.80
1992	3.02	3.11	2.22	2.15
1996	1.75	1.73	1.41	1.42
Mean 80s	2.29	3.27	2.06	1.50
Mean 90s	2.39	2.42	1.82	1.78

Source: FOS (1999): Poverty Profile for Nigeria (1980 - 1996).

Table 5.13: Poverty incidence in rice producing states (%)

Year	National	Niger	Benue	Ondo/Ekiti
1980	28.1	34.0	23.6	24.9
1985	46.3	61.4	42.9	47.3
1992	42.7	29.9	40.8	46.6
1996	65.6	52.9	64.2	71.6
Mean 80s	37.2	47.7	33.3	36.1
Mean 90s	54.2	41.4	52.5	59.1

Source: FOS (1999): Poverty Profile of Nigeria (1980 - 1996).

creation of national wealth, the effects are not sustainable enough to have a dramatic impact on the hitherto high national poverty rate, which is more severe in the rural areas. It is expected that in the long run the benefits of rice production will be felt significantly in poor rural households, in which case the poor will benefit most in terms of access to cheaper rice or improved income as rice producers.

5.3 Environmental impacts

5.3.1 Rice production cycle and environmental impact

Most stages of the rice production cycle exhibit specific environmental impacts as depicted in Table 5.14. Such impacts begin with the process of establishing rice farms. The latter generally involves nursery preparation in the rain fed lowland farming system, although some farmers using irrigation systems also engage in nursery preparation. The size of nursery farms varies depending on the actual size of planned rice farms where transplanting takes place. In the upland farming system, when nurseries are not prepared seeds are planted manually in two ways: on small plots dibbling is carried out using a hoe, and on fairly large and mechanized plots the seeds are broadcast manually after the first harrowing and then covered up with soil during the second harrowing. Irrespective of farm practices, some vegetation loss and soil disturbance take place due to land clearing, slash and burn and land preparation processes. In small farms manual labour involves the use of simple

Table 5.14: Major rice cultivation and processing activities and their environmental effects

Activity stage	Inputs/activities	Output and environmental effects
1) Establishment of farms nursery preparation		
Slash and burn land preparation	Nursery construction	(i) Deforestation, defoliation, biodegradable waste
Transplanting/sowing	Bush burning after slashing; Clear felling of trees	(ii) Land degradation and damage to ecosystem e.g. soil; aggravates/initiates soil erosion; water pollution
Maintenance of young plants – weed control – pest and disease control – bird scaring – fertilizer application	Agro-chemicals, clothing, belt, etc. Manual weeding and thinning	(iii) Damaging effect on human health of agro-chemicals due to salinization, water logging, poisoning, siltation eutrophication and ground water pollution
2) Maintenance of mature farms – weed control – pest and disease control – bird scaring	As above	(i) Wetland rice system generates methane and nitrous oxide (ii) Damage to eco-system e.g. from agro-chemicals, methane and nitrous oxide (iii) Damage to human health by agro-chemicals
3) Harvesting	Manual in small farms; combine harvesters in medium and large farms	Grit and paddy husks create waste management problem
4) Threshing	Manual in small farms but mechanized in medium and large farms.	Grit, paddy husks and broken rice grains produced as wastes, thus contributing to on- and off-farm waste management problems. Dust particles may cause eyesight and breathing problems.

Activity stage	Inputs/activities	Output and environmental effects
5) Processing 5.1) Pre-cleaning and washing	Using winnowing and sieving technologies Washing paddy to remove dust	(i) Grit (sand and silt), waste water, husks (ii) Grit and small insects (iii) Contributes to off-farm waste problems
5.2) Parboiling	Soaking paddy in water and heating it	(iv) Causes eyesight and breathing problems (v) Heat from waste water may kill some soil micro-organisms (vi) Foul odour if not drained
5.3) Drying	Drying in the sun (roadside, etc.) by small-scale producers	(i) Broken rice grains, husks, grit (ii) Electric generator-induced pollutants such as smoke, oxides of carbon, nitrogen, sulphur and petrol and diesel exhaust fumes
5.4) Milling	a) Hand-pounding system b) Automated milling system	(i) As in 5.1 (iii) and (iv) (ii) As in 5.1 (iii) and (iv) iii) Methane contributes to destruction of the ozone layer iv) These chemical pollutants are human and ecological health hazards
6) Transportation	Vehicles (e.g. trucks, motorcycles, etc.) are used to transport inputs and outputs (unprocessed and processed rice) (i) Soil compaction causing land degradation	(ii) Air pollution from vehicle exhaust fumes harmful to human health and the environment
7) Disposal of rice husk/dust	Burning	(i) Smoke, soot and air pollution contribute to greenhouse gases (ii) Human eyesight and respiratory problems

Source: After Olokesusi, 2002.

farm tools such as hoes, cutlasses and hand forks, while ploughs are used in medium to large-scale farms for mechanical clearing and land preparation. It is important to note that certain agro-chemicals are applied in the pre-planting phase. These include *Apron star* for seed treatment, and herbicides such as *Gramoxone* and *Touch down*. Fertilizers including NPK, urea and super-phosphate are applied in order to enhance yield.

Established rice diseases in Nigeria include leaf and neck blast, and rice yellow mottle virus (RYMV). Common pests include the gall midge, the stalk-eyed fly, lepidopterous stem borers and the grain storage moth. Herbicides such as *Profit 500 EC* and insecticides like *Nuvacron 40SCW* and *Karate* are therefore applied to prevent rice damage. On small farms weeding and bird scaring are carried out manually, whereas large farm operators use mechanised aerial spraying of agro-chemicals to control weeds, pests and diseases, though birds are scared off using a combination of manual and mechanical techniques.

The majority of rice producers harvest the rice manually using sickles and cutlasses, though large farms use combine harvesters. Rice is then processed in multiple stages. The first stage is the winnowing, which, when carried out manually, involves the use of a stream of air to blow away separated rice husks (or chaff) from the panicles (grains) before women carry out the threshing by

pressing the paddy between their feet and winnow a second time by drawing the grains from a bowl placed above the head, allowing the wind to blow away the chaff (Adenekan, 2002). The paddy is then pre-cleaned in water to remove silt, sand and tough husks, soaked in clean water, and then heated until it becomes somewhat tender. Finally, to facilitate proper milling, the parboiled rice is sun dried and then pounded manually. In some rice-producing areas, a few operators have installed automated milling machines and destoners. For large-scale farming, all the activities associated with processing are mechanised. During post-harvest storage, agro-chemicals such as *Actellic dust* and *25 EC* are applied. These activities, as well as the transportation of inputs and milled rice, require the use of bicycles and vehicles (cars, vans, trucks, motorcycles, boats, etc.). In addition, all the above activities have significant environmental impacts, as highlighted in Table 5.14.

5.3.2 Environmental impact assessment *(ex post)*

Increased land conversion

In 1980, about 0.55 million hectares of land were devoted to producing rice. By 2000, this figure had risen to 1.6 million hectares, representing an increase of 1.05 million hectares (191 per cent), or an average of 52,500 hectares (9.55 per cent) annually. In spite of this fairly high land-conversion rate, the average annual rice yield has remained 1.9 tons per hectare. It can thus be concluded that gross production increases have resulted from substantial extensification and limited intensification.

Obviously the increasing extensification is unsustainable on account of the finite nature of available land, competition from other crops and the institutional arrangements that guide ownership or user rights over land. Even though the banks of the rivers Niger and Benue and some other small rivers are being considered as new areas for irrigated rice production, management of these developments is critical and must be properly planned beforehand.

Deforestation and biodiversity loss

Both extensification and intensification processes constitute potential sources of pressure on the natural resource base and its quality. Clearing and cropping of new forest lands was noticed in the study areas, particularly in Ekiti State where rice is assuming great importance among farmers. Deforestation exposes fragile lands to soil erosion, and rainfall washes soils into rivers and streams creating further ecological problems such as siltation. Expansion into steep hillsides, as noticed again in the state of Ekiti, increases physical vulnerability to soil erosion and lowland flooding. Deforestation results in the loss of the carbon sequestration service of trees, thus exacerbating the greenhouse effect and global climate change phenomenon. It also results in the loss of bio-diversity (both flora and fauna), watershed protection and other environmental services offered by trees. Deforestation also causes land degradation because of the increased access to common property resources.[11] Intensive farming, which is the case for a significant proportion of the locally produced rice, means that fallow periods are shortened, with concomitant loss of soil nutrients and organic matter. This situation, coupled with low external inputs, is responsible for the stagnation in rice yield. To further lend credence to the relatively low use of farm inputs, 26.7 per cent of the sampled farmers affirmed they were not using enough agro-chemicals.

Salinization and soil nutrient degradation

The poor conditions of the country's irrigation system predispose irrigated rice farming to unsustainability because intensive use of irrigation

[11] Hardin, 1968; Hardin and Baden, 1977.

water under poor drainage conditions usually causes water logging followed by a rise in the water table. Under dry and humid conditions salt builds up (salinization) and reduces yields.[12] In this study 72.8 per cent of the respondents opined that the quality of the farmland has declined, while almost 32 per cent confirmed soil erosion was a problem. This finding is not unexpected given the low level of external inputs used even though these are critical to maintaining the quality of the soil.

Mechanization and the use of tractors are not common in the lowlands. Rather, preparation of the land and planting are manual, with women and children performing the dibbling with hoes and broadcasting of seeds. However, in the upland large-scale farms, tractors are used for ploughing and double harrowing. Rice is broadcast and incorporated during the second harrowing. Consequently, not much ecological disturbance occurs, except during slash and burn land preparation.

Soil surveys and analyses show that the soils are generally acidic or slightly acidic (pH ranges from 4.5 to 6.3), which is potentially good for rice production. Most of the farms sampled showed deficiencies in N, P, Exchangeable Bases, etc. This indicates under-fertilization, which could be attributed to the farmers' financial inability to purchase the mineral fertilizer or the unavailability of fertilizer.

From the results of soil analyses (presented in Tables 5.1 and 5.2 of Appendix 1), it can be seen that the soil is undergoing "nutrient mining". Visual observation in most of the farms indicated obvious nutrient deficiencies and "hidden hunger". For example, the levels of organic matter of the surface soil ranged from low to high (0.3 to 4.4 per cent) but over 80 per cent of the soil has less than 2 per cent organic matter, which is the critical level. Since organic matter is the storehouse of exchangeable cations, it is obvious why key elements such as Ca, Mg, K, and Na in most of the soils fall within the low range. Exchangeable Ca ranged from 0.03-15.66 cmol/kg^{-1}, and Mg, 0.247-0.28 cmol/kg^{-1}. About 50 per cent of the soil is below the critical ranges of 2.0 to 2.6 for Ca^{++}, 0.15 for K and 0.45 for Mg. With this very low exchangeable base reserve, there is a high nutrient imbalance predisposing production to low yield and low crop quality.

To complicate matters, phosphorous levels should range between 0.6 and 29.7 mg/kg^{-1}, yet over 60 percent of the fields have levels below the critical level of 10mg/kg^{-1}. Similarly, total Nitrogen (N) ranges from 0.14 to 4.43 mg/kg^{-1} and over 50 per cent of the soils have less than 1.5 mg/kg^{-1}, which is also critically low. Total nitrogen is normally related to organic matter but when crop residues are burnt the N reserve is lost.

The micro-nutrients, Cu (0.1 to 6.0 mg/kg^{-1}) and Zn (0.59 to 74.6 mg/kg^{-1}) are generally low in the soils, in contrast to Mn (11.3-512.5 mgkg^{-1}) and Fe (373-1,770mgkg^{-1}) which are present at toxic levels. Induced by low pH, as observed by Olaleye (2002) who worked on wetland soils for rain fed rice cultivation in Nigeria, the major limitations to rice cultivation are low exchangeable cations, low organic matter, and low available P_1. This situation may predispose rice plants to ferrolysis and excess Fe uptake, which is expressed as "bronzing" or yellow symptoms.

Independent surveys carried out by the Ebonyi Agricultural Development Programme and Tararaba State Field Evaluation Unit in the lowland rice producing areas show that most of the soils are acidic (pH 4.6-5.7), highly deficient in exchangeable bases, and low in available P and organic matter. Similarly, the WARDA-sponsored research carried out by Adesanwo (2002) gave a partial diagnostic survey of selected rice fields in Ogun state. The study was carried out to assess the impact of farmers' fertility management systems on the nutrient status of the soil. The farms visited are located in Moloko, Asipa, Ilaro, Iperu, Wasimi and

[12] Olokesusi, 1992a.

Ayiuere, where land had been left fallow for over five years. The farming practices ranged from single cropping to maize/cassava/rice intercropping. The soil analysis revealed a pH range of 5.4 to 7.3, and organic matter ranged from 2.44 to 3.26 per cent, which is low compared to the established critical level. N ranged between 0.098 and 0.014 per cent, exchangeable Ca is above the critical range of 2.9-3.0 cmol/kg^{1}, while exchangeable K was at the critical range of 1-0.4 cmol/kg^{-1}. The exchangeable Mg ranged from 1.1-1.8 cmol/kg^{-1}. The exchangeable Mn is 0.3 cmol kg^{-1} in site number 2, with pH <5.4. There is no exchange acidity in sites 1, 3, 4 and 5. Fe concentration was high at 9.2-31 cmol/kg Fe ha^{1}, which is in fact evidence of Fe toxicity. If the above cropping situation continues, this field may need to be abandoned or an integrated nutrient conservation method will need to be employed.

The implications of the nutrient deficiency status of most of the soils in rice-producing areas in Nigeria cannot be ignored and there is thus an urgent need for fertility strategies beyond mineral fertilizer application. Compatible diversification of farming systems, crop rotation, integrated management, rapid grain legume fallowing technique (Mucuna), plant residue recycling and organic agriculture are required, among others.

Impaired water quality

On-farm water quality is somewhat impaired by irrigated rice farming due to the perennial rice paddy flooding. This and the continuous cultivation of rice often lead to gradual deficiencies in micronutrients and build up of soil and water toxicities. High iron build-up is a problem in the country (Adeoye, 2002). The main reason for abandoning upland plots in the study areas was because of declining soil fertility and bronzing effects. Analysis of water samples indicates that the $N0_3$ levels of boreholes in Abakaliki and Ejeti processing areas are higher than the WHO standard (see Appendix 5). The phosphate level is normal apart from Ejeti borehole, but the acidity level was around the lower range of pH 6.5.

Production of hazardous gases and agricultural wastes

Land clearing methods still involve bush burning. This generated excessive carbon dioxide and related oxides of carbon, all of which are pollutants that contribute to increasing the "greenhouse effect", causing changes in circulation patterns affecting local climate, and contributing to overall global warming with an ensuing rise in the sea level. Much needed nitrogen (N) and sulphur (S) are also lost during the bush burning process. Yet, these organic materials could be incorporated for organic recycling and restoration of soil fertility. Methane and nitrous oxide are two greenhouse gases produced in paddy/wet land farming systems. Similarly, oxides of carbon and nitrogen as well as some organic gases are produced in the process of burning rice husks.[13]

Agricultural wastes are improperly managed on the field after the harvest and at rice processing mills. The wastes are either dumped or openly incinerated. Incineration generates a lot of smoke and the ash residue is toxic. Soot from milling engine exhaust fumes pervades the air and forms deposits on adjoining farmlands. The loss from field paddy husk and ashes are estimated at as much as: K 0.3 per cent, Ca 0.12 per cent, N 0.7 per cent. Table 5.15 shows the levels of N, P and K in plants harvested from the fields. The rice dust is a potential source of fertilizer that could be composted and recycled into the field as it has a high level of K which is an element required for grain fixation. Table 5.16 shows the recycling potential of rice husk, bran and ash in rice production.

Effects of agro-chemicals

Only 23.3 per cent of the farmers claimed to be aware of the environmental effects of agro-chemi-

[13] Pagiola, 1999.

Table 5.15: Plant and processing dust analysis of selected rice-growing locations

State	Location	Ecology	Fertiliser Use	%N	%P	%K
Niger	Ejeti	Flood Plain	Yes	0.91	0.10	4.00
	Emitsundandan	Flood Plain	Yes	0.53	0.04	2.71
	Boku	Flood Plain	Yes	0.59	0.04	1.61
Ebonyi	Abakaliki	Lowland	Yes	1.32	0.08	2.84
	Abakaliki	Lowland	No	0.58	0.07	1.75
	Abakaliki	*Lowland	No	0.91	0.07	2.61
	Rice dust (fresh)			0.13	0.12	11.52
	Rice dust (stale)			0.11	0.08	17.01

Note: *Lowland rice field cultivated for the first time after long fallow.

Table 5.16: Mineral analysis of rice husk, ash and bran (%)

Element	Husk	Ash	Bran
Carbon	16.17	-	-
Phosphorous	-	3.30	0.91
Nitrogen	0.70	0.71	0.17
Potassium	0.30	1.45	0.97
Calcium	0.12	0.45	0.19
Silicon	80.30	95.15	-
Magnesium	-	0.25	2.62
Aluminium	-	0.14	-

Source: Akanmu and Shridhar (2002).

cals. This may be due to the low use of purchased inputs because of their high cost and unavailability. However, some farmers reported contracting certain diseases such as skin rashes and respiratory problems that they attributed to the application and handling of agro-chemicals. This is not unexpected in view of the fact that 82.5 per cent of the respondents normally do not wear protective devices when applying agro-chemicals. Gaseous pollutants from electrical equipment used for parboiling and milling also constitute health hazards. In addition to these health risk factors, there is the psychological disorientation caused by the foul smell emanating from the high piles of rice dust/husk and wastewaters from processing activities.

To conclude this section it is pertinent to examine which of the multiple environmental impacts of rice production are critical and deserve priority policy attention. In a largely smallholder production system characterized by rudimentary technologies such as is the case in rice production in Nigeria, increased land conversion and deforestation are key critical environmental impacts. Extensification may lead to incursion into and deterioration of marginal lands. The loss of biomass that accompanies deforestation and bush burning deprives soil of organic materials that would normally have decayed to add nutrients to the soil. Bush burning has a negative impact on biodiversity as it destroys habitats, living things and organic matter within the local environment.

5.3.3 *Ex ante* environmental impact assessment of accelerated rice production

Conceptually, the policy of accelerated rice production could be achieved by expanding the farmland area (extensification), increasing production per unit area (i.e. increased productivity or intensification) or a combination of both methods.

Extensification implies expanding the rice-growing area through the conversion of marginal lands and crop substitution on existing farms. Technically, this option is feasible but some environmental challenges must be overcome especially in rain fed upland areas where fallow periods have diminished significantly as a result of human settlement expansion and population pressures. Improved crop management practices must accompany any anticipated increase in rice production in this ecological zone. One of the findings is that there are greater prospects for increasing rice output in the lowland farming system than in the upland system. Moreover the yield is higher in the former. The flood plains and inland valleys where expansion could take place cover about 1,130,000 hectares of which only about 10-25 per cent is currently exploited (Agabi *et al*., 1995; Osiname, 2002) (see Appendix 2).

Assuming 15 per cent of the inland valleys are presently cropped, there is a potential gross area of 960,500 hectares available which, if used for growing rice, could increase rice production by about 1.5 to 2.2 million tons, assuming the yield remains at the current level of 1.9 tons/ha. However, expansion into this zone will require new investments in land development, access roads, innovation and institutional arrangements. Awareness campaigns are also required to control the health hazards associated with lowland farming.

Another potential means of expanding production is irrigation farming. The perceived opportunity for rice production under this system prompted the federal and state Governments to develop various types of irrigation projects with support from the World Bank (see Appendix 3). However, many of the projects now require improvements, so accelerating rice production will require greater attention to the rehabilitation of existing irrigation systems, especially as these have the highest yield potential (about four metric tons/ha). Indeed, additional irrigation systems can still be developed based on land-use planning principles. If the existing irrigation capacity were to be fully developed, extensification as a strategy for increased rice production may not be necessary.

It is planned that the NERICA rice hybrid seed will be promoted to take advantage of several of the benefits established during field trials. One of the most critical single factors determining whether a given farmer can use new seeds is whether or not there is an adequate supply of water, so irrigation farming plays an important role in accelerating rice production. In addition, new high-yielding rice varieties require much more labour than the indigenous varieties, including at harvest, and achieving the full potential of such new seeds requires fertilization as well as frequent weeding otherwise the fertilizer and water would be converted into weeds rather than food.

The second option for attaining self-reliance in rice production is to increase the yield per unit area of farmland. Participatory research under the country's National Agricultural Research System has confirmed that current rice yields could be doubled, and that this potential yield is not an abstract value but a reality if known improved technologies are used to mitigate and ameliorate major biotic and abiotic stress.[14]

Rice production expansion through extensification and/or intensification has a profound potential impact on the environment. If not properly managed, it may worsen land conversion and degradation, deforestation, loss of biodiversity and fouling of the quality and biophysical properties of water and surrounding areas.

[14] Osiname, 2002.

Increased land conversion

Because of the surfeit of appropriate technologies and availability of labour, area expansion is considered key to meeting the goal of doubling rice output within three years. This means that different types of vegetation in the various rice agro-ecologies could be converted into farmlands. It is envisaged that about 1.5-2.5 million hectares of land, including that regarded as marginal land, could be brought under rice farming between 2003 and 2007. Converting wild lands and slightly modified land to agriculture often involves ploughing (for large-scale farms), which is known to reduce soil organic matter. Both slash and burn rice farming and the absence of fallow periods lead to the loss of organic matter in the soil with a concomitant reduction in infiltration, fertility and ability of the soil to retain fertilizers and water. Since it is expected that farmers would apply more external inputs such as mineral fertilizers and pesticides in this scenario, it can be described as having potentially significant adverse environmental and human health impacts.

Deforestation and loss of biodiversity

As indicated earlier, substantial areas of land will be cleared, which is likely to result in loss of forests and other forms of vegetation. Deforestation by clearing or burning releases much of the carbon contained in the forests into the atmosphere thereby increasing the amount of atmospheric greenhouse gases.

There are three main dimensions of biodiversity: the genetic variation within species and population, the number of species and the preservation of habitat.[15] All forms of biodiversity are critical for their use, non-use and option values. For agriculture, the significance of variations within a species is especially critical. The productivity of existing crops and livestock rests to a significant extent on harnessing the genetic variation that exists within each species. A reduction in biodiversity could negatively impact socio-economic development and human health based on losses of useful materials, genetic stocks and the ecological services of intact or undisturbed ecosystems. On the other hand, wild biodiversity is concerned with the conservation of a diverse number of species, including wild plants and animal species.

Biodiversity loss is particularly critical in Nigeria because the livelihoods of a significant proportion of the population depend on free and open access to a great variety of biological resources for food, fuel, machines, housing materials and economic security. Nigeria's dependence on biodiversity is barely captured in economic statistics and the national accounting system, which reduces the adequate perception of the significance of biodiversity in national development. However, the management of habitats that have been modified for human activities and needs, such as farmland, is important.

Available information from the FME and the World Bank indicates that human activities and natural changes have had an impact on biodiversity. For instance, out of 274 species of mammals in 1996, at least 27 were classified as being under threat of extinction in 2002. Similarly, out of 681 bird species, 9 were threatened by 2002. For higher plants, 37 species out of the estimated 4,715 are under threat of extinction as well (World Bank, 2003). It is important that these considerations guide Nigeria's rice production expansion programme by ensuring that the opportunity cost of production expansion is minimal and does not involve irreversible damage to the existing biodiversity.

Water quality

A major challenge of accelerated rice production is how to prevent the deterioration of the quality of water on rice farms. With rising human population and per capita water consumption, efficient allocation of water resources among competing

[15] Srivastava, Smith and Forno, 1996.

users has become increasingly problematic. Part of the rice production programme will involve irrigation. Irrigation farming allows farmers to eliminate or minimize the effects of inadequate soil water on plant growth. Irrigation farming, however, can lead to a number of ecological externalities and environmental changes, as this farming system not only ensures that more water is available for the crops, it can also cause an increase in deep percolation and surface run-off, especially if application efficiency is low as a result of poor water management by farmers. Again, in the case of more intensive agricultural practices, the use of agro-chemical inputs is increased. Based on several studies, insect proliferation usually emerges in tropical countries where irrigation water collects in small depressions, and at the end of the irrigation basin. Such ecological systems favour the propagation of schistosomiasis and onchocerciasis, among other diseases. Between 1993 and 1998 77,056 cases of schistosomiasis and 14,392,700 cases of onchocerciasis were reported (FOS, 1999). Furthermore, the waterlogged soils can cause salt build up (salinization). This reduces yields, which results in farms being abandoned. Under lowland and upland farming systems, bush clearing and de-stumping will promote erosion and transportation of loose topsoil by run-off water into surface water and lead to siltation in watercourses. Where the groundwater level is high, so is the pollution potential.

5.3.4 Biodiversity

Rice-growing communities in Nigeria are culturally tied to genetic biodiversity. Field investigations revealed that farmers and rice researchers are concerned about the displacement of indigenous varieties by "terminate technology" whereby the improved varieties are not viable for replant, and instead farmers have to buy new seeds for every crop. This is significant in that farmers have enjoyed the culture of raising their own seeds for years. The NERICAs were developed from crosses between indigenous African rice *Oryza glaberima* and the introduced Asian rice (*Oryza sativa*). African rice has been adapting to the environment for over 3,500 years but has poor yield. Asian rice, which was only introduced about 500 years ago, has much higher yield potential but falls prey to many indigenous African problems such as pests. NERICA combines the best of both into a single plant with high yield, vigorous early growth that helps smoulder weeds, short growth duration that reduces the amount of labour required to grow the crop, high protein content, resistance to African diseases and pests, and tolerance to drought. The potential for immediate NERICA production in Nigeria is about 0.5 million hectares. Since NERICA is being proven in various agro-ecologies in Nigeria as the answer to rice sufficiency for home consumption, there is a need to educate both farmers and other stakeholders that it is not a genetically modified (GM) crop. Presently, some countries in Southern Africa are rejecting GM maize and wheat for reasons of safety and potential agronomic problems in the future, and a transatlantic row is ongoing between Europe and the United States over the safety of consuming GM foods (*The Guardian*, Wednesday 25 June, 2003, p.1).

Rice provides more than just calories; it is also the basis of both biological and cultural diversity. Rice represents a great deal to the Asians, from culture to history, landscape, religion and social identity. In parts of India, paddy seeds are exchanged by farmers and offered to the village deities especially at the inception of each new agricultural cycle. At harvest, rice is worshipped as the goddess of wealth (Dhanalakshmi). Vandana Shiva, Director of the Research Foundation for Science, Technology and Ecology in Delhi, India and a prominent environmental activist, argued that the corporate control of rice and the encroachment of chemicals and machines of the green revolution have destroyed nearly 220,000 rice varieties that existed in India and brought in 40 new insect pests and 12 new diseases for peasant farmers to cope with. Shiva also alleged that many transgenic rice varieties have been developed on false premises. For example, the breeding of vitamin A rice called "Golden Rice" involved huge investments and took over ten years to realise. The rice was developed at

the Institute of Plant Sciences in Zurich by introducing three genes taken from daffodets and bactence into rice straw to produce yellow rice with a high level of beta-carotene that is converted to vitamin A inside the body. The rice was also believed to prevent blindness. The whole programme is considered a colossal waste since less than 1 per cent of the daily vitamin A intake will be met, and over 90 per cent of vitamin A will still be provided from indigenous sources such as green leafy vegetables, fruits, coriander and curry leaves.

As Nigeria proceeds to implement its rice expansion programme, there are certain lessons that must be learned from the green revolution of the 1960s and 1970s:

a. Bumper production depended on the application of fertilizers, pesticides and irrigation to create conditions in which high-yielding modern varieties could thrive.

b. Reliance on seeds that have to be bought each year and that require expensive inputs may exclude many resource-poor farmers from the benefits of trade liberalization.

c. Widespread use of just a few high-yielding varieties of rice may lead to the loss of traditional varieties and increased vulnerability to pests and diseases. NERICAs may be the only varieties grown on Nigerian soil and thus pose a challenge for pest and disease control. Already in Ebonyi State the Agriculture Development Project (ADP) has discovered a pest (called new midge) that is not yet classified.[16]

d. Environmental damage resulting from the misuse of external inputs such as fertilizer and pesticides outweighs the advantages of using these inputs. For example, experts estimate that only about half of the fertilizer applied actually benefits crops while the remainder is lost from the soil through volatilisation and run-off. Also, pesticides not only kill target pests, they may also contaminate land and water and foster the emergence of resistant strains of pests.

e. There is also the tendency for farmers to switch from growing age-old crops that sustain livelihoods and the economy (maize, sorghum, yam, fruits and vegetables) to producing rice when the latter commands high prices.

5.3.5 Poverty and environment interactions

It is now fairly well established that a recursive relationship exists between poverty and environmental degradation. The poor have a negative impact on the environment in a number of ways. First, the poor farmer is embroiled in a struggle for survival on a day-to-day basis and at subsistence levels of consumption, so has little or no incentive for anticipatory or forward planning, such as investing in natural resource conservation. For instance, measures to conserve the soil and maintain its fertility are often neglected due to faulty decision-making, and the traditional soil-quality regeneration process that involves leaving farmland fallow is hardly ever exercised because of population pressures and the expansion of settlements.

Second, the poor further aggravate environmental degradation due to their inability to cope with risks such as public policy interventions in input and output markets and unfavourable land tenure arrangements, among others. The traditional coping strategies such as social networks, selling stored crops and out-migration of household members, are becoming less attractive or more difficult to actualise. Similarly, most poor women lack access to formal markets for credit, agricultural insurance as well as current and reliable environmental information, including extension services, providing advice on ways and means of mitigating and/or ameliorating risks that are associated with agricultural activities.

[16] ESADP, 2002.

On the other hand, poverty can also be exacerbated by environmental degradation. It is widely known in Nigeria that, because of their vulnerability, the poor are exposed more than any other group to avoidable pollution such as unsafe water that carries infectious and parasitic diseases, and because the division of labour is such that women and children are usually responsible for fetching water they are more prone to these water-related diseases. This is in addition to health problems arising from exposure to particulates, soot and smoke associated with in-door cooking with bio-fuels in poorly ventilated houses in rural communities. The risk of becoming poorer as a result of sudden and severe weather-related events such as floods and droughts increases because the poor live in qualitatively deficient homes built on unstable slopes and marginal lands.

Deforestation also affects the poor in that it compels them, especially women and children, to devote an increasing proportion of their time and energy to the collection of fuel wood because they regularly have to go further in search of it, and this subjects them to stress and reduces the potential benefits of agricultural practices.

The poor are also more likely to suffer respiratory and skin diseases in the process of combating pests and diseases through the inappropriate application of and exposure to hazardous agro-chemicals, because poor farmers are often illiterate and thus unable to read the instruction labels on the packaging materials and extension services are generally deficient. The upsurge in HIV/AIDS cases in the country has been predicted to impact very severely on diverse social and economic spheres and invariably the poor bear the brunt. Poor health has a negative impact on productivity, thereby initiating a downward spiral in income, social well-being and environmental degradation.[17] Not only are the poor more exposed to health risks, they lack the financial resources to pay for the necessary health care and medicines.

Rural-urban migration and farm abandonment represent some of the coping strategies of the poor, but this is found to be inapplicable to agricultural activities.[18]

5.3.6 Some issues and trade-offs in agriculture and environmental conservation

Nigeria's transition to sustainable agriculture is imperative. Sustainable agriculture can only be achieved by the decisions and actions of each farmer on the basis of his/her own interests, needs and priorities, including responsibilities to the goal of national sustainability. A major challenge is to develop an acceptable and successful strategy for sustainable agriculture. The transfer and development of agricultural technology are crucial aspects. The use of environmentally sound agricultural technologies, whether exogenously or endogenously developed, can contribute significantly to productivity and the sustainability of resources through reduced energy consumption, pollution control, waste reduction and conservation.

The relationship between inputs and outputs and the holistic impact of economic activities such as farming on the environment is not static but dynamic. Consequently, the question is whether the positive forces of substitution, technological innovation and structural change can compensate for any deleterious effects on the overall growth in rice production.

The process of agricultural production should always take into account the true monetary value of the environment and its protection. Formulating an environmental policy on the basis of the costs to society of environmental damage rests on the assumption that environmental conditions will worsen without pollution control and environmental conservation. Thus, it is crucial to determine the monetary costs of damage and protection and understand what factors influence the value

[17] UNAIDS, 2001; Ajakaiye, 2002; Akande, 2002.
[18] Olokesusi, 2001.

individuals in different rice-growing ecologies place on environmental protection and conservation.

The national and state environmental protection agencies are either unable or unwilling to enforce established instruments. Yet, the appropriateness of these instruments and the capabilities and staffing of these agencies are critical to sustainable agriculture. Strategies that promote more environmentally sound agricultural technologies and discourage environmentally damaging ones must involve the appropriate combination of market instruments, public awareness and intervention processes.

Environmentally sustainable agriculture is not a discrete entity. Rather it is a system that encompasses external inputs, processes, products, and services as well as technology. This implies that, to be sustainable, rice production should address the scarcity of external inputs and technology options. The process should develop human capacity and promote gender and social equity, bearing in mind their linkages and interdependencies in the context of sustainable development.

The elasticity in the willingness to pay to avoid environmental damage and protect natural resources as well as the correlation between rising incomes and environmental quality explain why the poor and rich have different perceptions regarding certain environmental problems and their solutions. This again has to do with the type of technology involved. Although rice farmers might be willing to pay for on-farm soil erosion problems, they may not be too interested in community-wide environmental problems unless these directly affect their livelihoods.

The Nigerian environment is important in addressing poverty. Creating employment with environment-enhancing projects and allied technologies should be a desirable action to reduce poverty. This concerns particularly labour-intensive technologies, although they may be less attractive investments than capital-intensive alternatives.

Because human capital has to be improved to achieve sustainability, poverty reduction should be perceived in terms of a social investment in the short-term consumption needs of the poor as well as a means of improving their contribution to the accumulation of capital. With respect to income generation in the future, a trade-off is implicit because the degree of poverty reduction has to be significant enough to generate productivity, consumption, income and welfare, otherwise the opportunity costs will be negative.[19]

[19] Olokesusi and Ogbu, 1995.

6. Valuation of the impacts

6.1 Methodology chosen

Existing methodologies for the purpose of valuating of the economic, social and environmental impacts of trade liberalization measures are not sacrosanct; they all have serious empirical and technical limitations. However, since the intention of conducting valuation is not necessarily to put actual values on the various impacts but mainly to reflect existing patterns and the nature of costs and benefits involved in domestic rice production, several methods can be applied as long as they are appropriate and easy to apply. Furthermore, a single methodological approach may not adequately reflect the three components of valuation intended, that is, economic, social and environmental impacts. Even the computable general equilibrium model (CGE) that may capture the three-prong effects cannot be easily applied in the case of Nigeria, where there are serious data limitations. It was, therefore, decided to apply a series of approaches (gross margin analysis, WTP, etc) that adequately reflect the value of resources connected with Nigeria's rice production activities.

It should also be remembered that Nigeria is a net importer of rice, with half of the country's current rice requirements being covered by imports. 'Exports' to neighbouring countries such as Chad and Niger Republic are actually re-exports and are a result of opportunistic trading activities by border-zone communities and traders. This is largely informal and unrecorded trade. The valuation exercise, therefore, will mainly concentrate on current domestic production capacity, and no attempt shall be made to consider the costs and benefits to the economy of imported rice or its re-export.

6.2 Valuation of economic impacts

The main positive economic impacts of rice production in Nigeria may be summarized as follows:

- increased domestic rice production
- reduction in imports and, thus, preservation of foreign exchange
- increased employment in rice-related activities
- diversification in downstream and upstream rice-related activities
- improved production practices, including technology transfer
- increased scientific research to support rice
- opportunities for exports to neighbouring countries
- improved household income and poverty reduction
- improved nutrition among the poor
- development of infrastructures to support rice production activities.

In order to eliminate the difficulty posed by the lack of adequate data to evaluate in quantitative terms each of the elements of the economic impact, a gross margin analytical technique that measures the returns on farm expenditures, family labour and entrepreneurship was carried out. The gross-margin may be perceived as the return on investment or production expenditure in rice farming. In order to apply this procedure, first the projected supplies of rice between 2000 and 2010 were ascertained. In this respect, the projections by Ajakaiye and Akande (1999) were used. The supply projections were based on time series data on domestic production to which regression techniques were applied to obtain the trend coefficient for rice. The trend coefficient was then applied to the average

domestic rice production figures for the three-year period 1990 to 1992 and then projected to obtain the domestic production figures for paddy rice for the period 2000 to 2010. The milled rice equivalent for each year was also obtained, as were the projected farm gate prices per ton of milled rice, the projected production cost per ton and the overall total variable costs. The final step was to deduct the total variable costs from the corresponding milled rice value for each year to obtain the gross margin (see Table 6.1).

The gross margin thus measures the producers' returns on labour and management inputs. However, this approach is limited in that the gross margin also technically includes the value of the biomass lost in order to cultivate rice. The value or cost of this has not been incorporated or accounted for in the total variable cost outlay. If this had been done the producers' gross margin would have been much lower than the figures seen in Table 6.1. For the environmental impact assessment that is considered later, efforts are made to valuate the biomass lost as a result of rice cultivation. Environmental protection initiatives that may be required to deal with the consequences of biomass loss also involve costs that need to be considered in the valuation process.

Since Nigeria has already begun its rice expansion programme with the objective of doubling or more its output, it can be expected that there will be a corresponding increase in each of the variables considered in Table 6.1 (that is, paddy output, milled rice, etc.), except for farm gate rice prices that may be depressed as a result of significant output. In essence, increased rice production might lead to doubling of the figures for the factors considered in Table 6.1.

In the actual calculation of the cost-benefit outcome of rice production the following relationships were calculated:

Discounted benefit, PV(B) is given as:

$$\text{(i)} \qquad PV(B) \; 3 \frac{B_t}{(1+r)^t} \; \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where, B_t is the cash inflow in year t; and r is the discount rate.

Discounted cost, PV(C) is given as:

$$\text{(ii)} \qquad PV(C) \; 3 \frac{C_t}{(1+r)^t} \; \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where, C_t is the cost or expenditure outflow in year t and r is the discount rate.

The benefit-cost ratio in year t is then expressed as:

$$\text{(i)} \qquad 3 \frac{B_t}{(1+r)^t} \; / \; 3\frac{C_t}{(1+r)^t} \; \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Table 6.1: Projected gross margin accruing to rice producers, 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Paddy Output (1,000 tons)	4,140	4,445	4,750	5,055	5,360	5,665	5,970	6,276	6,581	6,886	7,191
Milled (rice 1,000 tons)	2,402	2,578	2,755	2,932	3,109	3,286	3,463	3,640	3,817	3,994	4,171
Farmgate prices of milled rice (N/ton)	48,000	52,800	58,080	63,888	70,277	77,304	85,034	93,538	120,892	113,181	124,500
Milled rice value (N billion)	115.3	136.1	160.1	187.4	218.6	254.0	294.4	340.3	392.8	452.1	519.3
Variable Cost (N/ton)	12,000	13,800	15,870	18,251	20,988	24,136	27,757	31,920	36,708	42,215	48,547
Total Variable Cost (N billion)	49.7	61.3	75.4	92.3	112.5	136.7	165.7	200.3	241.6	290.7	349.1
Gross Margin (N billion)	65.6	74.8	84.7	95.1	106.1	117.3	128.7	140.0	151.2	161.4	170.2

Sources: (1) Ajakaiye and Akande (1999).
(2) Author's calculation.

Table 6.2: Cost-benefit analysis of rice production

	Revenue	TVC	Gross margin	Discount rate+1	NPV	B	C	B/C
2000	115.3	49.7	65.6	1.15	57.04	100.26	43.21	2.32
2001	136.1	61.3	74.8	1.15	65.04	118.34	53.30	2.22
2002	160.1	75.4	84.7	1.15	73.65	139.21	65.56	2.12
2003	187.4	92.3	95.1	1.15	82.69	162.95	80.26	2.03
2004	218.6	112.5	106.1	1.15	92.26	190.08	97.82	1.94
2005	254.0	136.7	117.3	1.15	102.00	220.86	118.86	1.86
2006	294.4	165.7	128.7	1.15	111.91	256.00	144.08	1.78
2007	340.3	200.3	140.0	1.15	121.73	295.91	174.17	1.70
2008	392.8	241.6	151.2	1.15	131.47	341.56	210.08	1.63
2009	452.1	290.7	161.4	1.15	140.34	393.13	252.78	1.56
2010	519.3	349.1	170.2	1.15	148.00	451.56	303.56	1.49
				Total	1126.17	2669.91	1543.73	
				NPV	1126.17			
				B/C	1.72			

TVC = Total Variable Cost; NPV = Net Present Value, B = Discount benefits
C = Discounted Costs; B/C = Benefit-cost ratio.
Source: Calculated by the author.

For the projected period, 2000-2010, the benefit-cost ratio is calculated thus:

$$B/C = \frac{\sum_{t=1}^{n} Bt / (1+r)^1}{\sum_{t+1}^{n} Ct / (1+r)^1} \quad \ldots\ldots(4)$$

where, n is the number of years and all the other terms are as previously defined.

The investment viability of the rice expansion programme for a ten-year period may also be calculated using the Net Present Value (NPV) approach that is calculated as follows:

$$\text{NPV} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^1} \quad \ldots\ldots\ldots\ldots\ldots(5)$$

where, all terms are as previously defined.

The calculations were conducted from a social perspective. A discount rate of 15 per cent, which is the prime lending rate, and therefore the rate for a preferred sector such as agriculture, was used as the appropriate cost of capital. The results obtained are as shown in Table 6.2. The results indicate that the production increase is beneficial to society in both the short and long terms, though the long-term benefits will certainly depend on the sustainable management of natural resources.

6.3 Social valuation

The impact of the rice sector on social wellbeing is mostly indirect, apart from the direct effects of income gains, wage increases, increased enterprise size and so on. The social valuation is assessed on the basis of the indirect effects or externalities and is the net sum of social benefits and social costs where the social costs and benefits are the value of impacts not directly related to the economy of production. If for instance upstream employment is generated, say, in livestock firms using rice products and by-products (a positive externality) but family labour loss results in the primary production sector due to the former, a net social value accrues that may boost or depress the overall economic benefit of the production system, depending on the more profound of the two effects. Consequently, social valuation in the study area requires the use of certain critical cost items and demographic statistics of the population to estimate the aggregate social costs and benefit streams arising from such externalities.

The most obvious positive externalities of the rice sector are in upstream employment generation (transport, loading and bagging), income (room rates) for hotels and guesthouses from migrant workers, marginal income gains from each additional Naira spent on improving the education of children and youths, and incremental yield from farms using rice wastes as organic fertilizer. On the negative side are the costs of treating rice-related ailments such as guinea worm, filariasis, schistosomiasis, respiratory tract infections, chest pains, waist pains and certain traumas associated with parboiling e.g. burns. More importantly, there is also the social cost of the transmission of diseases such as HIV/AIDS through greater social interaction. These costs include treatment, death and burial costs, loss of family livelihoods and so on. This is especially relevant in Benue state, which records the highest AIDS prevalence rates in Nigeria.

6.4 Environmental valuation

One of the major policy issues arising from the attainment of sustainable agriculture is the estimation of appropriate monetary values for natural resources. The efficient use of natural resources, human-made capital and human resources is a vital pre-requisite for sustainable development and agricultural sustainability. Without proper natural resource valuation, and under conditions of apparent ubiquitous and abundant resources, ill-defined property rights, economic and political uncertainties and monopolistic conditions and Government subsidisation of certain resources, there is a tendency to exacerbate local resource consumption, causing environmental degradation and the depletion of valuable natural resources.[20]

Empirically, environmental impacts are often difficult to measure in physical terms. It is equally difficult to valuate physical damage and assets in monetary terms. UNEP (2001) reviewed some of the existing techniques for carrying out environmental valuation. One of these is the WTP, which has been adopted in this study. However, in generating the values used in the WTP method, one of the 'revealed preferences' or 'stated preferences' techniques was used, namely the contingent valuation method (CVM). CVM is a hypothetical direct method for obtaining the economic value of an environmental amenity, attribute or resource. Environmental benefits are rarely bought and sold in the market. Rather, the commodities traded in the market embody environmental values. For instance, the prices (or rent) of houses located near airports and waste disposal sites are generally lower than those of houses located in quiet areas or far from waste disposal sites, *ceteris paribus.* The statistical determination of the house price (or rent), illustrates a way of finding surrogate markets in which the un-marketed environmental good has some influence. The decision to use the WTP approach is based on three main factors. First of all because of the inherent simplicity of the CVM approach, particularly in a rural and illiterate setting. Second, in the absence of people's preferences being revealed in markets, the contingent valuation technique simply involves collecting information on consumers' preferences by asking direct questions about their willingness to pay. Third, the income level of respondents poses a constraint but the willingness to accept payment for a loss is not constrained.[21]

Theoretical basis of the WTP approach

The WTP approach is a form of monetary valuation that indicates the minimum value that an individual will place on the quality of his or her environment. In other words, the values represent how much people are prepared to spend in preventing damage either to the environment or to themselves. This approach approximates actual expenditures and, therefore, the importance that individuals attach to impacts on the environment and on themselves.

[20] Salau and Aina, 1992; Olokesusi, l987.
[21] Pearce and Markandya, 1988; Olokesusi, 1992b.

Table 6.3: Is erosion a problem in your community?

	Benue		Niger		Ekiti		All States	
	Freq	%	Freq.	%	Freq.	%	Freq.	%
Yes	32	53.3	24	40.0	2	3.3	58	32.2
No	28	46.7	34	56.7	58	96.7	120	66.7
Non Response	-	-	2	3.3	-	-	-	1.1
Total	60	100.0	60	100.0	60	100.0	180	100.0

Source: Field Work (2002).

Table 6.4: Are you willing to pay for environmental protection and management?

	Benue		Niger		Ekiti		All States	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Yes	30	50.0	25	41.7	34	56.7	89	49.4
No	28	46.7	35	58.3	24	40.0	87	48.3
Non Response	2	3.3	-	-	2	3.3	4	2.3
Total	60	100.0	60	100.0	60	100.0	60	100.0

Source: Field Survey (2002).

Methodology for WTP

Environmental valuation was obtained by offering the farmers a well-described hypothetical choice in the survey questionnaire, which involved presenting all the relevant characteristics of a specified farmland option. These include soil and water quality, yield and erosion control. Two hypothetical options were then described to the farmers for consideration and choice-making: the first involved rice farming under conditions of good soil and water quality, followed by high crop yield; and the other involved the exact opposite to the first choice. The farmers were then asked what proportion of their profit from rice production they would be willing to pay on an annual basis to enable them to realize and benefit from the first choice. The trained interviewers elicited information on the bids by showing the respondents a Likert scale ruler with a zero to ten range. In this regard, zero and ten represent zero and 100 per cent of the profit respectively.

The responses were applied to the mean profits, following which the accruable sums of money from each of the four profit categories were computed. The WTP bids would yield the revenues that could be generated if that particular option were actually provided. This estimate could then be compared with the actual data on soil fertility and water quality maintenance and capital costs so as to determine the extent to which cost recovery is possible.

Research findings

The working hypothesis is that a farmer would be more willing to pay for environmental protection when the perceived farmland quality is low. The main research finding is that, even though a very high proportion of the respondents were aware of the declining quality of farmland, only 49.4 per cent of the sample indicated their willingness to pay for environmental protection and management. In an attempt to elicit information on how much those who elected to pay would be willing to pay, a question was posed to determine the proportion of their farm profit that they would be willing to set aside for environmental protection and management. As revealed by Table 6.3, there is a drastic decline in the proportion of those willing to pay as

Table 6.5: What proportion of your profit are you willing to pay for environmental protection?

	Benue		Niger		Ekiti		All States	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1- 10%	27	45.0	15	25.0	15	25.0	57	31.7
11- 20%	2	3.3	18	30.0	4	6.7	24	13.3
21- 30%	-	-	2	3.3	4	6.7	6	3.3
31- 40%	-	-	-	-	2	3.3	2	1.1
Non Response	31	51.7	25	41.7	35	58.3	91	50.6
Total	60	100.0	60	100.0	60	100.0	180	100.0

Source: Field Work (2002).

Table 6.6: Amount accrued from WTP responses (in Naira)

	Benue		Niger		Ekiti		All States	
	Mean Profit	Amount Accruable	Mean Profit	Amount Accruable	Mean Profit	Amount Accruable	Mean Profit	Accruable Amount
1-10%	2,999	80,973.0	12,902	193,530.0	12,536	1,888,040	7,968	454,176.0
11-20%	-11,155	-2,310.0	19,337	348,066.0	-	0.00	16,775	402,600.0
21-30%	-	-0.00	16,192	32,384	21,536	86,144	18,033	108,198.0
31-40%	-	-0.00	-	0.00	33,465	66,930	33,465	66,930.0
Total	-	78,663.0	-	573,980.0	-	341,114.0	-	1,031,904.0

Source: Field Work; 2002.

the share of profit set aside for environmental management rises. For instance, almost 32 per cent of the respondents were willing to pay between one and ten per cent of their profits, while only 3.3, and l.l per cent of the respondents were willing to pay 21-30 and 31-40 per cent of their profits respectively.

Based on the gross profit margins profile of the sample farmers and the responses shown in Table 6.3, the amounts accrued for the purpose of meeting all or part of the costs of on-farm environmental protection and management are as recorded in Table 6.4. While farmers in Niger and Ekiti states are willing to pay relatively substantial sums for environmental restitution, their counterparts in Benue state are willing to make only marginal sacrifices for the same purpose. Such divergence in WTP values might be due to differences in the level of environmental awareness, perceptions of the critical contributions made by sound environmental quality to agricultural productivity, risk aversion of respondents, and other reasons. Overall, a little over N 1 million was accrued from this small but carefully selected sample of 89 willing farmers. If the estimated population of rice farmers of about 690,000 were to show a similar disposition towards environmental protection, a total of about N 770 million could be made available annually by rice farmers for this purpose.

7. Policy implications

Several policy initiatives are suggested by the findings of this study to mitigate the negative impacts and enhance the positive impacts of rice production activities in Nigeria. The proposed policy measures aim to ensure sustainable production to enhance the socio-economic benefits and improve environmental management. It is equally important to secure legal and institutional frameworks that can guide activities in the rice sector, particularly the import and export of rice-related inputs and outputs.

7.1 Identification of policies

Several policy issues are of considerable importance as revealed in the findings. Socio-economic policy considerations are as follows:

a. Rice is not only a generator of income and employment for producers, processors, marketers and service providers it is also an important item in the household food basket of the poor and rich alike. It contributes to food security and poverty reduction and provides high quality nutrition for all Nigerians, whose tastes have largely tilted towards improved food grains.

b. Because of increasing demand among the various strata of the population, rice has become a strategic food and its availability has significant socio-economic and political impacts and consequences, particularly among the urban population. Ensuring regular availability at affordable prices has become a challenge for policy makers and Government.

c. Rice production and processing has significant negative environmental impacts. The destruction of biomass, loss or disturbance of biodiversity, pollution of water and soil and generalized environmental deterioration are consequences of unsustainable production practices and the absence of environmental management.

d. The positive impacts of the rice economy are not evenly distributed. While producers in certain rice-producing regions are positively affected in almost all of the dimensions assessed, those in Ekiti State – which is in the heart of the metropolitan South West of Nigeria and close to ports – face stiff competition from imported rice and the discriminatory tendencies among consumers against local rice and in favour of imported rice. It is, therefore, important to adapt policy measures to the different regions based on perceived negative impacts that need to be eliminated or reduced, and positive effects that need to be enhanced.

e. The rate of penetration of imported rice into different parts of the country will increase over time so competition currently faced by producers in Ekiti State will eventually be experienced by producers located further inland. The current positive social effects may not be sustainable unless medium to long-term policies are designed to address the structural and technological deficiencies in rice production systems.

f. There appears to be a mono-directional demand pattern in terms of human consumption of rice. The current increased activity in the largely rural Benue and Niger states is due to newly evolving rice consumption patterns, though this demand has a time and quantum limit. The demand patterns need to be ascertained with a view to satisfying the different categories of consumers.

The positive structural changes observed can only be sustained if there is continued incremental demand to stimulate an increase in production. With increasing rice output and the need to find appropriate outlets, it will become important to segment the market and provide different brands or grades of rice to meet the demand attributes of each type of consumer.

g. The net social benefit from the rice economy needs to be enhanced by addressing the negative externalities. In Benue state, HIV/AIDS is a real threat, the losses from which are yet to be fully quantified. There is no doubt that the positive social impacts of rice production in this state, which also happens to be one of the states with the highest potential for increased rice cultivation, will be drastically curtailed by the threat of HIV/AIDS. Diseases associated with rice-growing such as filariasis, guinea worm and respiratory infections also constitute quality-of-life threats and must therefore be controlled.

h. The effect of the rice economy on poverty reduction is fairly obvious from this analysis, especially in the area of employment generation and income enhancement. The agencies for poverty reduction must organize around these potentially viable economic units rather than create new projects that are not as culturally suitable.

Most of the policy initiatives that could be considered deal with improving the following negative environmental impacts identified in the study:

– increased land conversion to rice farms and expansion into marginal lands
– deforestation and land degradation
– loss of biodiversity
– emission of air pollutants
– salinization and soil nutrient degradation
– contribution to greenhouse gases and climate change
– human health effects.

Consequently, various policies and practices can be devised to promote sustainable rice production under trade liberalization. The key points for policy consideration to ensure environmentally friendly rice production activities are described below.

Soil and water quality management

There are two important considerations to promote and sustain soil and water quality:

a. There should be specific evaluations of soil and water environments in different agro-ecological zones to assess their current potential and prioritise their use and development in phases to ensure sustainable production.

b. Findings show that current rice production practices cause depletion in soil nutrients and lead to negative nutrient balance and are thus unsustainable. In order for the yield-enhancing technologies to be applied profitably, it is crucial that soil fertility management be improved. While re-capitalising the soil by applying chemical fertilizers is desirable in view of its current low application, it is insufficient on its own to improve the management of soil fertility. The efficiency and economical use of chemical fertilizers should be improved as well. In this context farmers should be made aware of the necessity for them to adopt integrated soil fertility (nutrient) management (ISFM) techniques. Such techniques include the following:
   – combining chemical fertilizers with crop residue recycling, green manure, fodder crops, mucuna fallow or intercropping
   – zero tillage
   – supplementing micro-nutrients using planted shrubs (local and exotic) with herbicidal and pesticidal properties at potent levels.

Irrigation water must be well managed and monitored because of salinity, alkalinity, pollution and eutrophication due to heavy use of fertilizer and other agro-chemicals. In many rice-producing environments that are inundated by water plants, animals and humans are subject to water pollution through seepages into rivers and shallow wells. By the same token, water quality under non-irrigated farming systems should be protected. Soil fertility

is not technology *per se*, rather it requires fundamental adaptations of agricultural policies to encourage farmers to transfer some of their investments into ISFM and incite the private sector to invest in the development and maintenance of agricultural input and output markets.

Pest control

With so many rice diseases needing to be controlled there is a need to raise the awareness of farmers on preventive measures. Recommended measures, particularly in reference to RYMV, include burning infected plant material, ploughing infected fields just after harvest and before the following cropping season, and flooding the fields. Other phytosanitary practices include encouraging farmers to wash hands and shoes and avoid contaminated fields.

The choice of pest management techniques is based on costs and returns, just as it is with the adoption of new seedlings and soil and water management. Although farmers used very little chemical pesticides, cases of human health problems were found as a result of inappropriate application. Moreover, although some of the pesticides are lethal to the ecosystem, rice pests constitute a menace without them. It is therefore necessary to eliminate the environmentally unfriendly pest management techniques and promote positive strategies such as integrated pest management (IPM) through public awareness, research and capacity building involving key stakeholders. As part of this strategy there should be a well thought out and dynamic national IPM policy.

Biodiversity conservation

Biodiversity improvement can be achieved by allowing for a variety of habitats such as shelterbelts, alley cropping, riparian buffer strips, windbreaks and strip cropping. Furthermore, diverse landscape habitats create more niches for fauna and flora, some of which are beneficial in pest control. These methods need to be applied in rice-producing regions. For instance, strip cropping would be advisable in the hilly fields of Ekiti state and parts of Osun State where rice is cultivated.

Promote recycling and organic farming

The many rice-dust heaps currently littering the landscape should be composted into organic fertilizer as this will not only enhance waste management and environmental sanitation, it will also generate returns for investors, since the composted waste is recycled to supply much needed soil nutrients, especially silicon, and replace those that have been depleted. This could be just the starting point of organic agriculture. In addition, organic matter from cow dung and poultry waste in appropriate ratios can be formed into organo-mineral fertilizer. Promotion of organic rice production and subsequent certification by such recognized non-governmental organisations (NGO) as the Rainforest Alliance, and the issuance of International Standards Organisation (ISO) 1400 is one policy option that could help achieve both economic growth and environmental sustainability. Eco-labelling or environmental certification would boost rice exports once Nigeria joins the league of exporters. This is partly in consonance with WTO Agreements but it also serves the desire to "green" international trade. Certification and adherence by Nigeria to established standards would enable her to cross the "standards divide" that is currently hindering effective participation in non-oil commodity exports.

In order to meet the challenges associated with international trade and environmental sustainability the following actions should be taken:

– facilitate access to reliable and current information
– improve the process, product quality assurance and monitoring and evaluation
– test and package products with a view to responding to market demands and trading partners' changing technical requirements (including eco-standards).

Raise awareness on sustainable agriculture

A major strategy for intervention is the promotion and creation of awareness among farmers on the necessity to create favourable environments for soil

and water management in particular, and sustainable rice production in general. For this reason, a series of grassroots training sessions and meetings should be organized. The key objective of such meetings should be to sensitise stakeholders (rice farmers, extension agents, agro-processors, farm input suppliers, policy makers in the areas of agriculture, water resources and the environment) on the necessity for sustainable rice production. These fora should provide the opportunity to develop a common understanding of the implications of unsustainable rice production and the probable ways of attaining sustainability. In particular, the issues of soil and water quality maintenance, pest and weed control, biodiversity conservation and environmentally friendly rice processing systems among others are to be addressed at such interactions. The meetings should also offer the chance to exchange knowledge and skills.

Electronic and print media can play key roles in raising public environmental consciousness. Appropriate information should be disseminated in local dialects so as to reach target audiences. Similarly, information, education, and communication (IEC) materials should be printed in the major languages and dialects and widely distributed.

Enforcement of the precautionary principle

With a view to maximising the benefits of trade liberalization, the Government should protect and conserve the environment by incorporating environmental conservation into liberalization programmes. Although sector-specific analyses of environmental impacts and mitigation remain relevant, the polluter-pays clause should be enforced in the Federal Environmental Policy in all sectors. This is expected to be part of the environmental guiding principle that is to be rooted in the compensation and realization of the full costs of the rice production cycle, including production costs, natural resource depletion and environmental costs.

Use of market incentives

It is worth noting that both the National Conservation Strategy and the Environmental Policy emphasize payment of full prices for natural resources such as petroleum, solid minerals, timber, water and energy. Towards this end, charges for irrigation water and land should reflect this principle. Other consumers of natural resources should also be subject to this policy. This step would stand sustainable agriculture in good stead. Since a good proportion of the sample farmers are willing to pay for the protection and conservation of the environment, the Government should devise a way of charging farmers for this purpose. Revenues accruing from this source as well as those collected from resource extraction and pollution activities should be reinvested in productive assets, preferably those with the highest social rate of return such as natural capital (e.g. soil and water quality improvement, re-forestation, etc.), health and education.

Access global environmental facility for conservation and protection

It has been established that methane (one of the greenhouse gases said to be responsible for global climate change) is emitted when rice is produced on wetlands and irrigated land. Therefore, as a signatory to the United Nations Framework Convention on Climate Change and the Kyoto Protocol, the Government should design projects to be funded under the Global Environment Facility (GEF) for the purposes of environmental protection and conservation.

Environmental monitoring

In order to ensure agricultural sustainability and environmental improvements, environmental conditions and trends should be continuously monitored. This fits very well with the initiation of the State of the Environment Reporting proposed in the 1999-2001 National Rolling Plan. From the outputs of this process it should be possible to ascertain the effectiveness of environmental restitution activities in the context of trade liberalization. The outputs will lead to the identification of agricultural enterprises that are not complying with established environmental quality standards so that appropriate sanctions can be enforced.

Improved legal and institutional arrangements

One of the key findings of this study is that most of the unintended externalities of rice production are a result of the failings of existing legal and institutional arrangements. This situation had led to inequality and inappropriate sharing of the burden in social conflicts over the use of natural resources. Emphasis should be on the devolution of responsibilities for the purposes of environmental protection and conservation. Local officials should be empowered to enforce environmental laws and provide necessary incentives for compliance.

Conduct further research

A major contribution to Nigeria expected from research activities is the increased awareness of the consequences of uncontrolled, unplanned and poorly managed environment and natural resource utilization. However, more elaborate research is required in various areas of rice-related activities that have implications for the environment. Such research would promote balanced and sustainable development in the rice sector. A few of the areas requiring further investigation are as follows:

a. There should be further research on the determinants of sustainability and degradation of the resource base. Multi-disciplinary research in this area should focus on agro-climatic issues, the storage and transportation of water, soil fertility, pests, weeds, diseases, the physiology of rice growth, biodiversity, economic issues and the interactions between these variables.

b. Introduction of the NERICA breed of rice must draw upon farmers' knowledge and be consistent with farmers' systems. In this way a solid base would be built upon knowledge of the resource base and biological processes that enhance sustainable food production.

c. Nigerian rice farmers need information about the efficacy of improved rice varieties, synthetic and organic fertilizers and herbicides. Demonstrated increases in rice productivity, income and living standards of rice farmers who adopt the improved farming practices will provide the necessary justification to convince other farmers on the efficacy of improved rice varieties, biofertilizers and herbicides.

7.2 Implementation strategy

Nigeria has considerable institutional capacity for environmental management. A regulatory body, the Federal Environmental Protection Agency (FEPA), was created as far back as 1988 and has today become the FME. A full-fledged ministerial institution underscores the importance the Government attaches to the issues of the Nigerian physical environment. A National Policy on Environment already exists and this is the main working document for the preservation and protection of the Nigerian environment. Since Nigeria is a federation, environmental regulatory bodies have also been established at the lower tiers of Government, i.e. at state and local Government levels, to oversee environment-related issues at the grassroots level. A host of NGOs also exist and are concerned with natural resource conservation and sustainable development.

However, the existence of a regulatory agency is not a sufficient condition to ensure the sanctity of the environment. Indeed, the extents to which existing regulations and standards are enforced demonstrate the effectiveness of institutional frameworks established at public expense. Thus, in order to implement the policies recommended in this study, an arrangement within the existing institutional framework must be evolved. This becomes critically important for the development of environmentally friendly rice production projects in Nigeria. However, the arrangement must be based on the participatory principle in which all stakeholders are encouraged to play a role.

Structure for implementation

It is proposed that a monitoring and policy implementation body be set up to undertake implementation and execution of the policy initiatives recommended under this study. The membership of the body should consist of the following:

– Federal Ministry of Environment – Chairman

– Federal Ministry of Agriculture and Rural Development – Deputy Chairman
– Federal Ministry of Water Resources – Member
– Federal Ministry of Commerce - Member
– Presidential Committee on Rice Production – Member
– National Agricultural Extension and Rural Liaison Services (NAERLS) – Member
– Mass Media – Member
– Non-governmental Organisations – Member
– National Cereal Research Institute – Member
– Nigerian Institute of Social and Economic Research (NISER) – Member
– Rice Producer Association of Nigeria – Member
– Cooperative Federation of Nigeria – Member

The tasks to be performed by this body may be summarized as follows:

a. Review the existing legislations and standards set for environmental management and identify those directly related to agricultural production.

b. Review the various policy proposals contained in this study and elsewhere and initiate plans for their implementation.

c. Coordinate with the Presidential Committee on rice production on how to incorporate environmentally friendly practices into rice-related activities.

d. Identify and draw up hierarchical steps for the processes and modalities for implementing policy suggestions, including community-based action plans. Promote the dissemination of environmental information and capacity building specifically focused on the policy proposals.

e. Periodically review implementation progress and make necessary amendments to ensure that all action plans are on course.

f. Find sources of funds to undertake its activities and plans.

The FME should be the focal point of the body because it is the statutory institution in charge of environmental matters, including policy formulation, planning, monitoring, enforcement of standards and regulations and general administration. The FME should take on the responsibility of organizing the body and running its activities. The inter-ministerial nature of the proposed body will enhance cooperation and the effectiveness of implementation. For instance, the FMARD, which is directly in charge of rice production as an agricultural activity, would be expected to play a prominent role in mobilizing resources and encouraging farming communities to participate in the programme. NAERLS, ADP, NGOs and community-based organizations (CBOs) would assist the FMARD this role. The National Cereal Research Institute (NCRI) will provide technical knowledge while NISER will undertake all socio-economic research and advice. The mass media will be responsible for disseminating information on the environment and the activities of the body.

Implementation schedule

The body will be expected to work out an implementation plan that may be executed over a five-year period during which it is expected that sufficient education and acceptable environmental practices will be passed on to rice producers across the country. It is believed that production of other commodities will also benefit from this initiative.

The implementation plan should be in steps or phases. The first step would be to inaugurate the implementation body and present its functions and assignments as well as the essential elements and major findings of this study. The body can then deliberate on how it will conduct its activities and decide on meetings and the reporting format.

The next phase would be a dialogue or workshop with a large group of stakeholders on the need for effective management of the environmental impacts of rice production. The proposed action plan of the implementation body should also be presented at the enlarged stakeholders' meetings.

A third phase will involve the design of all instruments, market-based or otherwise, targeted at environmental management. These should be subjected to thorough debate, and pilot studies may

be conducted to assess the workability of the proposals. Meanwhile, collaboration should be established with NGOs working in the rural areas, and CBOs should be identified as agents to disseminate information on the environment-related action plan of the implementation body. Other local authorities such as the council of chiefs and traditional rulers should also be involved.

The final phase would be the implementation, including action, monitoring, feedback, modification and overall assessment of the effectiveness of the action plan. The results and impacts of various activities should be obvious to the individuals in the rice sector and to the general public and Government.

Financing the implementation plan

The funds for implementing the proposed plan should come from the Government (via the various ministries and departments), overseas development assistance (ODA) and grants from development partners and agencies including UNEP. Broad-based financial support would be necessary given the financial implications of organising meetings, training, on-farm demonstrations and movement across Nigeria. Estimates indicate that between US$ 250,000 and US$ 500,000 may be required annually to cover the cost of the activities of the implementation agency.

8. Project experience and conclusion

Nigeria aspires to operate an agricultural system that does not deplete, pollute or disrupt the ecological balance of natural systems in order to achieve sustainability in production and optimise output for present and future generations. This is imperative because nearly two-thirds of Nigeria's population of over 130 million people depend on agriculture and natural resources for their livelihoods. Any damage to or assault on the environment would have untold repercussions for this huge population that is expected to increase significantly in future.

This project has generated considerable experience and perception in several ways including the following:

a. The entire project has been quite innovative in terms of its conception, execution and in the application of findings. It is a desirable new thrust in research activities, particularly activities that have significant implications for development. The participatory nature of the study draws on the wider perception and ideas on issues relating to the environment and sustainable development. Each group of stakeholders was able to perceive the implications of certain courses of action and its effects on corporate interest and welfare, making it easier to reach consensus and ensure agreement on ways to promote environmentally friendly and sustainable primary commodity production, including rice cultivation. There is also a better understanding of the expected role of each stakeholder and why each role needs to be performed efficiently. The interaction fostered by the project further consolidates existing alliances and broadens the consultative mechanism needed to put in place an effective development project and realize stated objectives.

b. The study is quite revealing of the depth of penetration of rice in household food consumption in Nigeria. It is significant to note that Nigeria is the largest producer of rice in sub-Saharan Africa, with increasing numbers of farmers switching to rice cultivation as a diversification strategy away from cocoa, palm produce, rubber and other tree crops that dominated the so-called cash-based production practices in the past. In the past 20 years Nigeria has also imported staggering volumes of rice to meet consumer demand. Thus, rice has significant implications for trade, production and diversification in the Nigerian economy.

c. The study is a significant and timely contribution to the process of expanding rice production in Nigeria. As a consequence of what may be perceived as excessive imports, which hover around 1 million tons per year, the Government decided to make Nigeria self-sufficient in rice by 2005. This implies that Nigeria will need to cultivate over 5 million hectares of rice annually, which carries great repercussions for the environment and the natural resource base of the nation. The results of this study draws attention to all categories of stakeholders on the measures that need to be taken to prevent or ameliorate the negative consequences of this unprecedented rice production expansion.

d. However, the project experience has also shown that rice producers and intending new entrants into the sector have not exhibited great enthusiasm for the Government's expansion plan. The reservations may be traced to the

unstable nature of Government policies particularly in a nation that has just emerged from military dictatorship and that is characterized by policy reversals and lack of continuity. People fear they will not receive sufficient incentives (inputs, services, etc.) to guarantee profitable rice production and the Government would thus need to create an environment conducive to profitable rice production by reviewing its trade and domestic production policies to make them profitable for smallholder production.

e. The study has clearly shown the positive and negative impacts of rice production in economic, social and environmental areas of development. The environmental impacts in particular call for serious considerations and ameliorative measures. Environmental effects of agricultural production activities rarely receive adequate attention, mainly because of the large proportion of the population involved in farming and whose means of livelihood must not be disrupted. The rudimentary technology used is assumed to have minimal negative environmental impact, but the cumulative impact of the activities of numerous farmers, irrespective of technological practices, could affect the biodiversity in a way that makes production unsustainable. Environmental control measures would therefore need to be promoted among rice producers and paddy processors.

f. The study has equally accentuated the divergent interests that stakeholders pursue and how each tries to maximize his gains and pass off negative outcomes to others. However, the study also demonstrates that consensus can be reached when it is based on the understanding and appreciation of the concerns and points of view of others. Policy makers would need to always consider this behavioural pattern in arriving at optimal decisions in project proposals and implementation.

g. The Government and stakeholders must ensure that producers comply with existing standards and regulations in the use of agro-chemicals and other practices that have significant environmental impacts. Public enlightenment and education on standards and regulations must be conducted regularly to remind producers of their obligations to society in terms of environmental stewardship.

h. The lacuna in rice information and data is quite vast. Irregular, divergent and inconsistent data on the same variable pervade the agricultural arena including the rice sector. There is a need to clean up the database to adequately reflect developments in the rice sector. The statutory responsibility for data gathering in Nigeria is vested in the FOS, which needs to be adequately funded to carry out this function effectively.

i. The need to develop rural infrastructures (roads, water, health, schools, etc) to raise the living standards of rice-producing communities cannot be over-emphasised. Post-harvest losses, for instance, could be greatly reduced if efficient transportation systems existed to facilitate domestic trade.

j. The project has also highlighted the need for further studies on trade effects and domestic production policies on agricultural output in Nigeria. There is a need for more enlightenment on the role of the WTO in international trade. It is also important to know how the WTO disciplines affect Nigeria's efforts and drive towards domestic food self-sufficiency and food security concerns.

In conclusion, Nigeria's new rice sector policy has commenced. It aims to discourage imports and take advantage of the comparative advantage existing in certain production regions and natural habitats such as the *fadamas*, flood plains and swamp areas. It will be necessary to integrate environmental control measures from the onset and create mechanisms to promptly address any unanticipated negative effects on the environment. This will require the establishment of a monitoring unit composed of stakeholders who would be required to flag off a warning signal once an untoward development traceable to rice production activities is noticed in the natural resource base.

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Appendix 1: Soil, plant and water analysis

Description of survey areas

Rice farms were selected for soil and water sampling in two of the major rice-growing areas – Niger and Ebonyi states.

In Niger state four sites, namely Bida, Ejeti, Oboku and Emitsundandan, were selected for the purposes of soil and water sampling. Bida falls between Lat 9°1 E and Long 6°1 N in the guinea savannah of Nigeria. A mosaic of woody lowland and secondary grasses characterizes the vegetation. The most prominent rice cultivation system is the lowland system, using the flood plains and the irrigated swamps. Most of the lowlands are situated close to a major water source (rivers and streams) and cover a large expanse of land (5-10ha.).

Ejeti has a flood plain of about five hectares. It is bordered on the lower slope by river Ejeti, which is known to flood into the adjourning plains, preparing them for rice cultivation. Planting in this locality commences towards the end of the rainy season (October) when the water level must have gone down considerably retaining only sufficient moisture for rice cultivation. The plain is partitioned into plots of about (20x20m) that are shared among the rice farmers in the village. Rivers provide water through the surface irrigation method. Mineral fertilizer is a major input used by farmers in this locality. On some of the plots visited, bronzing of the rice plant was noticed, which is a symptom of iron toxicity. Iron toxicity is the main reason for abandoning plots in the lowland localities.

Boku has a large flood plain adjoining a seasonal river. Rice crops in this locality depend on the water captured at the peak of the rainy season, so planting commences earlier. Fragmentation of holdings in land space is practiced and most farmers use fertilizer to obtain good yield.

Emitsundandan has a large expanse of irrigated lowland subjected to rice cultivation. The water is sourced from the upper course of a river, the water flows all season and hence it is channelled into the rice plot using a surface irrigation system. Mineral fertilizer use is prominent. The same land has been continuously cultivated for many years but with two crops rotated annually. Upland rice cultivation is also practiced in this locality. Fertilizer use is necessary to obtain good yields, however the upland rice cultivation system depends solely on rainfall for water supply.

In Eboyi state, farms were sampled in two towns namely Abakaliki and Afikpo. Abakaliki has a large swampy area, so rice cultivation is mainly based on the lowland system.

Soil, water and plant samples were taken from three local Governments representing the three zones: Abakaliki, Ezza and Afikpo. The area is in the derived savannah agro-ecological zone. Ebonyi River and its tributaries spread across the whole state. The state is 85 per cent agrarian while the most dominant crops are rice and yams. On the whole, the status and management of these lands were more or less similar. Land preparation is manual in the lowlands. Average land holdings ranged between 0.5 and 10 hectares.

Abakaliki: The farms in these areas were mostly intercropped with rice and yams, cassava, pumpkin, melon, peppers, tomatoes and cocoyam

etc. While rice is planted on flat land other crops that do not tolerate hydromorphic conditions are arranged in unique cropping patterns on very high and large mounds. Rice varieties are mixed, obtained from neighbours, self-maintained crops or rations, MANR, ADP and Research Institutes. Common varieties planted include ITA 306, CICADENE, ITA 357 and ITA 150. Upland rice has been newly introduced to the central zone of the state where large-scale farms now exist. Rainfall in the area ranges between 1250-2000 mm from April to November, with peaks in June and September. There is no heavy use of pesticides and herbicides. Farmers use small quantities of fertilizer, which is said to be generally available but quite expensive.

Afikpo: The rice farms in these areas were mostly sole crops.

Technique of sampling and analysis

Soil sampling was carried out at depths of 0-15 cm and 15-30 cm, and 20 core samples were taken at each site to constitute the composite sample. Plant and water samples were also collected appropriately.

A few plant samples were taken to crosscheck the NPK deficiencies observed in various fields and a few water samples were taken to evaluate the pH, NO_3, $PO4^{-3}$ and K^+ values. The emphasis was on nutrition and ability of the rice fields to support sustainable yields for local consumption, as well as in terms of the potential to increase yield per hectare for export. This is informed by trade liberalization and the WTO accord.

It is pertinent to note that existing data have revealed that most of the sampled areas in Niger State have been classified as sandy loam, while those of Ebonyi States are predominantly clay loam or sandy clay loam with only a few being sandy loam.

Interviews with farmers also confirmed that none of them used pesticides or herbicides, so there was no need for pesticide or herbicide analysis. Those who used mineral fertilizers applied them at grossly sub-optional rates. The risk of chemical fertilizer pollution of the soils and ground water is also minimal. The investigation thus concentrated on the nutritional evaluation of the soil environment for sustainable rice production.

The soil analysis

Results are presented in Tables 1 and 2 of this appendix. The organic matter level of the surface soils at 0-15 cm ranged from low to high (0.3- 4.74 per cent). These values do not differ markedly from the adjacent uncultivated soils, probably because of the cultural practice of bush burning in these areas on the one hand, and the advantage of stover recycling of the rice plant as cultivation of the succeeding year's crop progressed. The subsoil at a depth of 15-30 cm contains less organic matter. The areas under upland rice have lower organic carbon compared with the flood plains and the lowland areas. Higher organic carbon is recorded in Ebonyi state than in Niger State.

Nitrogen: Total nitrogen ranged from very low to high (0.14 – 4.43 g/kg^{-1}). Most of the soils are critically low (<1.5 g/kg^{-1}). This explains the acute nutritional deficiency of N and associated deficiencies of other major nutrients on visual observation of the matured plants. Obviously, taking the N dynamics into consideration, sustainable N use efficiency might be achieved by maintaining crop residue and organic fertilizer with a supplementary slow-releasing mineral nitrogen source.

Phosphorus: The phosphorus content of this soil ranged from (0.6 – 29.7) mg/kg^1. Like N, over 60 per cent of the soil has less than 10 mg/kg^{-1} which is the critical limit. However in some sites, both in the Middle Belt and South Zones, the available P is above critical level. Although phosphorus does not leach like nitrogen, it can easily be fixed in the presence of Fe^{++} and Al^{+++}, particularly in a hydromorphic soil where a reduction of Fe III to Fe II occurs.

Exchangeable bases: Calcium ranged from 0.03 - 15.66 $cmol/Kg^{-1}$. Potassium ranged from 0.18 – 0.20$cmol/Kg^{-1}$. Magnesium ranged from 0.28 -

2.47cmolKg^{-1}. About 50 per cent of the soil is below the critical limits of 2.00 – 2.60 for Ca, 0.15 for K and 0.45 for Mg. With this very low exchangeable base reserve, there is a high nutrient imbalance predisposing production to low yield and low crop quality.

Micronutrients: Manganese ranged from 11.3 – 512.50 mg/Kg^{-1}, iron from 373 – 1770 mg/Kg^{-1}, copper from 0.1- 6.00 ppm and zinc from 0.59 – 74.64 mg/Kg^{-1}. Mn and Fe are very high (critical limits of 25 and 145 respectively). Cu is low in many of the areas surveyed and Zn ranges from low to very high. The high values of Mn and Fe, which could have been caused by the low levels of the soil pH, could be responsible for low available P in the soil. This has to be looked into because of its effect on plant yield. Sustaining yield in a naturally nutrient unbalanced soil is an uphill task, and requires considerable integrated nutrient management strategies and a multidisciplinary approach.

Plant analysis

Table 3 of this appendix shows the content of rice plants sampled in different ecologies. Deficiency and toxicity levels are as set by Tanaka and Yoshida (1970). The percentage of nitrogen is below the critical level of 2.5 and the percentage of phosphorus is also within the deficiency range (0.1 – 1.00 per cent) but potassium is above the critical range. In summary, the plant analysis reveals the low N and P in the soil and explains the low yield in these rice ecologies.

H_2O analysis

The water samples from irrigation, ponds, lakes and wells show adequate prospects for rice cultivation. Since very little agro-chemicals are used at present there is little or no danger of pollution to the waterways. As more agro-chemical inputs are employed to raise yields, pollution with hazardous chemicals should be monitored.

Soil mining has been observed as a major problem. If this continues unchecked, it may increase the amount of degraded or marginal lands in the country. Ambitious and integrated managerial, physical, chemical, biological conservation strategies need to be adopted to prevent the situation from deteriorating.

There is hope that both the upland and lowland rice fields presently available will be manageable so that yield can be increased while new fields are created to meet the shortfall for export.

Summary

The agro-ecology and environment of rice production systems in Nigeria is characterized by the following nutrient management features:

– low nutrient reserve
– negative overall nutrient balance i.e. alarming rate of loss of mineral nutrients in croplands
– rice is mainly produced by small-scale farmers
– little or no external inputs are used in mixed cropping whereby two or more types of crop are inter-cropped with rice.

In order to achieve self-sufficiency in rice production and meet the needs of a rapidly expanding population, as well as increasing production for export in line with the high quality required by international markets, rice production will need to be intensified on existing rice-growing lands by enhancing the input of nutrients. While Nitrogen sources may be augmented through biological N fixation and high-grade organic sources of N in organo-mineral compost, other nutrients, especially P, must be supplied from external sources (i.e. rock phosphate for P, deposits of which are found in Sokoto, Ogun and Imo States of Nigeria). Sustainable crop production requires the adoption of an Integrated Nutrient Management strategy using balanced organic, biological and chemical nutrient inputs. Environmental consciousness of the production system in these three areas could provide a safety valve to achieving the aim of self-sufficiency and sustainable production for exportation. The action plan will involve the following:

a. Development of economically viable and nutrient conserving cropping systems that integrate N-fixing plants species with rice and other food crops in the mixture.

b. Development of an integrated watershed management approach that allows crop residue to be spared for use as mulch to produce compost.
c. Establishment of economic phosphorus requirement thresholds needed to sustain rice production and other crops on major soil types.
d. Integration of livestock into rice production to allow more efficient use of animal manure and household waste on cropland.
e. Renovate irrigation systems that currently supply water to 16 per cent of rice production, while 25 per cent are rain fed upland areas; 50 per cent are rain fed lowlands and 9 per cent are swamps and deep water systems.
f. Consistently rotate two crops each year; currently planting is from April to May and harvesting is in August.
g. Step up scientific farming methods, in collaboration with WARDA, in order to raise productivity to the levels that are being achieved in Asia.
h. Encourage subsidiary and auxiliary industries such as those producing fertilizer, particleboards, husk-full, bran oil, micronutrients, etc.

Rice absorbs large amounts of nutrients from the soil during its growth, and a large proportion of those nutrients can be found in the husk. For instance, silicon is heavily extracted from the soil but most often is not replaced through inputs, yet its role in strong straw and in preventing susceptibility to pests and diseases makes it important. One solution to the nutrient depletion and soil degradation is thus to make use of the vast amounts of rice dust. It has been estimated that the processing mill in Abakaliki, for instance, produces 10 metric tons per day of rice dust, and dust heaps have developed into a landscape of mountains around Eboyin and Benue States. In fact, this rice dust can be recycled into compost for organic fertilization in rice production and for other crops. This initiative would not only enhance waste management and environmental sanitation, it will also generate revenues for the states and replenish the nutrients that have been depleted from the soil, especially silicon, without the negative environmental impacts of chemical fertilizers.

Rice milling plant environment

In Eboyin State, which is one of the largest rice milling communities in Nigeria, there are several environmental pollutants within the millers' village. Within an approximately one-kilometre radius, the atmosphere is densely dusty and there is much noise and smoke pollution. This has been traced to the following factors:

– rice milling dust
– soot from the milling generators' exhaust fumes that settle on roofs, crops, land and people
– trampling of un-tarred dusty roads by marketers and their vehicles
– deafening noise caused by milling machines
– smoke, which irritates eyes.

Soil fertility problems

The identified soil fertility problems associated with rice farming include:

– nutrient depletion i.e. of N,P,K,Ca,Mg and some micronutrients Cu, Zn and Mn
– micronutrient toxicity due to low pH: iron toxicity leads to bronzing of rice leaves
– hydrological, climatic and biological constraints, water-holding problems leading to excessive reduction of Fe are primordial to conservation in rice-farming; it is also the basis for obtaining sustainable yields in view of achieving self-sufficiency and exportation of rice by the year 2005.

Appendix Table 1: Range of soil nutrients in Nigerian rice fields

Location	Description	Fertilizer Use	Status	Cultivation System	pH	% of Org. Matter	Total N (g/kg)	P mg kg-1	Ca (C mol/kg)	Mg (C mol/kg)	K (C mol/kg)	Na (C mol/kg)	Mn (C mol/kg)	Fe ppm	Cu PPM	Zn
NIGER STATE																
Ejeti	0-15	Yes	Cultivated	Flood Plain	4.7-5.1	2.72-4.01	0.84-3.16	11.2-16	1.54-2.04	0.43-1.15	0.17-0.21	0.16-0.22	0.6-2.8	489.00-662.00	0.70-2.10	1.6
Ejeti	15-30	Yes	Cultivated	Flood Plain	4.8-5.2	1.72-2.33	0.45-0.64	7.1-9	1.51-6.16	0.42-1.14	0.17-0.20	0.23-0.29	0.4-2.2	310.00-678.00	0.70-1.80	1.74
Ejeti	0-15	No	Uncultivated	Flood Plain	4.8	4.14	0.69	9.018	1.54	0.53	0.202	0.24	1.5	676.3	1.77	74
Ejeti	15-30	No	Uncultivated	Flood Plain	4.8	0.86	0.42	9.018	1.86	0.67	0.178	0.29	1.7	481.6	1.15	4
Boku	0-15	Yes	Cultivated	Flood Plain	4.8	0.65-1.36	3.57-4.43	5.01-6.51	1.05-2.29	0.51-0.73	0.16-0.2	0.23-0.33	24.5-33.8	431.00-496.00	1.00-2.00	0.1
Boku	15-30	Yes	Cultivated	Flood Plain	5.1	0.78-1.67	2.79-4.18	3.17-5.34	1.93-2.89	0.53.0.76	0.16-0.2	0.27-0.33	22.1-57.8	181.00-245.00	1.20-1.30	0.2
Boku	0-15	No	Uncultivated	Flood Plain	5.4	1.64	1.5	4.342	3.72	1.44	0.47	0.39	8	495.9	1.77	2
Boku	15-30	No	Uncultivated	Flood Plain	5.7	1.21	0.55	2.839	4.59	1.96	0.47	0.43	8	273.8	1.38	0
Emitsundandan	0-15	Yes	Cultivated	Lowland	5.3	1.03-2.07	0.64-0.97	8.01-15.5	1.23-1.58	0.55-0.58	0.16-0.2	0.23-0.27	3.00-8.50	1520.00-1770.00	0.30-0.50	21.15
Emitsundandan	15-30	Yes	Cultivated	Lowland	5	0.91-1.81	0.46-0.64	8.6-14.4	1.26-3.3	0.59-0.65	0.13-0.84	0.25-0.29	3.00-8.50	1150.00-1440.00	0.30-0.50	4.15
Emitsundandan	0-15	No	Uncultivated	Lowland	5	1.09	0.49	4.175	0.7	0.62	0.342	0.22	13.4	309.5	0.35	0
Emitsundandan	15-30	No	Uncultivated	Upland	4.9	1.87	0.32	2.338	1.05	0.61	0.14	0.25	9.3.0	316.6	0.69	1
Emitsundandan	0-15	Yes	Cultivated	Upland	5.5	2.59	0.26-0.79	11.0-12.7	1.37-5.57	0.45-1.23	0.2-0.3	0.29-0.42	8.80-11.20	88.70-288.10	0.10-0.40	0.4
Emitsundandan	15-30	Yes	Cultivated	Upland	5.9	0.3	0.29-0.39	6.0-6.7	0.35-2.46	0.28-0.49	0.2-0.4	0.38-0.39	8.80-11.50	145.50-302.40	0.20-0.30	0.22
Emitsundandan	0-15	No	Uncultivated	Upland	6.3	0.95	0.33	5.01	0.49	0.42	0.197	0.44	1.2	166.9	0.27	0
Emitsundandan	15-30	No	Uncultivated	Upland	6	2.07	0.14	5.177	0.35	0.44	0.18	0.24	1.6	159.7	0.12	4
EBONYI STATE																
Abakaliki Central	0-15	Yes	Cultivated	sw low	4.5-5.2	1.10-4.53	0.54-2.48	4.0-28.5	1.40-15.65	0.38-2.53	0.23-0.34	0.29-0.39	0.40-2.90	288.00-828.00	6.00-4.00	7.6
Abakaliki Central	15-30	Yes	Cultivated	sw low	4.8-5.1	1.29-3.19	0.64-2.11	7.5-26.7	1.58-13.64	0.42-2.20	0.20-0.27	0.26-0.33	0.30-2.20	438.00-597.00	1.00-4.00	56
Abakaliki Central	0-15	No	Uncultivated	sw low	5	4.4	2.02	0.668	1.83	0.87	0.27	0.27	1.1	741.5	1.04	2
Abakaliki Central	15-30	No	Uncultivated	sw low	4.7	1.86	2.12	0.668	1.75	1.15	0.23	0.29	1.2	575.2	1.73	3
Afikpo	0-15	Yes	Cultivated	sw low	5.2-5.3	1.55-4.74	0.95	10.4-25.4	1.58-7.90	0.32-0.99	0.16-0.27	0.33-0.42	1.80-17.90	561.00-727.00	1.70-5.20	8.34
Afikpo	15-30	Yes	Cultivated	sw low	5.3-5.5	1.03-3.19	0.6-2.05	-25	0.7-6.49	0.25-0.85	0.15-0.23	0.37-0.48	1.50-17.10	416.90-741.00	1.90-5.60	1.4
Afikpo	0-15	No	Uncultivated	sw low	5.6	1.14	0.55	7.682	1.26	0.27	0.14	0.42	1.9	553.5	1.27	3
Afikpo	15-30	No	Uncultivated	sw low	5.3	1.5	0.49	11.69	1.4	0.31	0.17	0.42	1.8	806.8	1.23	5

Source: soil survey, 2002.

Appendix Table 2: Mean values of soil nutrients in selected Nigerian rice fields

Location	Description Depth	Status System	Cultivation	Fertility	pH Matter	% Org. C	% Org. g kg-1	Total N ppm	P mol/kg)	Ca (C mol/kg)	Mg (C mol/kg)	K (C mol/kg)	Na (C mol/kg)	Mn (C ppm	Fe ppm	Cu	Nn
EBONYIN STATE																	
Abakaliki	0-15	Cultivated	Lowland	Yes	5.13	2.95	1.71	1.29	11.52	4.67	1.14	0.25	0.36	0.64	622.9	2	8.8
	15-30	Cultivated	Lowland	Yes	4.6	2.07	1.2	1.23	13.89	4.13	1.11	0.25	0.35	0.57	566.6	2.3	1.85
Abakaliki	0-15	Fallow	Lowland	No	5	3.76	1.91	2.02	0.67	1.83	0.87	0.23	0.27	0.11	74.15	1.04	2.17
	15-30	Fallow	Lowland	No	4.7	2.12	1.23	2.12	0.67	1.75	1.15	0.27	0.29	0.12	57.52	1.73	3.35
Afikpo	0-15	Cultivated	Lowland	Yes	5.3	2.48	1.43	0.95	18.81	4.26	1.26	0.21	0.39	1.02	66.19	3.48	17.86
	15-30	Cultivated	Lowland	Yes	5.43	1.82	1.05	1.09	18.43	3.27	1.75	0.19	0.41	0.9	56.58	1.63	16.33
Afikpo	0-15	Fallow	Lowland	No	5.6	1.14	0.66	0.55	7.68	1.26	0.27	0.14	0.42	0.18	55.35	1.27	0.39
	15-30	Fallow	Lowland	No	5.3	1.5	0.87	0.49	11.69	1.4	0.31	0.17	0.42	0.14	80.68	1.23	0.52
NIGER																	
Boku	0-15	Cultivated	Flood Plain	Yes	4.8	1.26	0.73	0.53	8.27	1.69	0.6	0.18	0.29	0.12	460	1.5	1.1
	15-30	Cultivated	Flood Plain	Yes	5.07	1.29	0.75	0.42	2.34	2.38	0.66	0.19	0.31	0.14	212	1.2	4.7
Boku	0-15	Fallow	Flood Plain	No	5.4	1.64	0.95	1.5	7.01	3.72	1.44	0.42	0.39	0.8	495.9	1.8	2.1
	15-30	Fallow	Flood Plain	No	5.7	1.21	0.7	0.55	11.75	4.59	1.96	0.42	0.43	0.8	273.8	1.4	0.6
Ejeti	0-15	Cultivated	Flood Plain	Yes	4.93	3.36	1.95	1.61	11.9	2.43	0.68	0.18	0.19	0.14	503.4	1.2	3.2
	15-30	Cultivated	Flood Plain	Yes	4.97	2.09	1.21	0.56	4.175	3.09	0.68	0.18	0.26	0.11	496.3	1.1	2.61
Ejeti	0-15	Fallow	Flood Plain	No	4.8	4.14	2.4	0.69	9.02	1.54	0.53	0.2	0.24	0.15	481.6	1.2	4.4
	15-30	Fallow	Flood Plain	No	4.8	0.86	0.5	0.42	9.24	1.86	0.67	0.18	0.29	0.17	467.2	1	1.3
Emitsundandan	0-15	Cultivated	Lowland	Yes	5.1	1.6	0.93	0.78	5.85	1.38	0.56	0.18	0.26	0.63	165.4	0.4	6.6
	15-30	Cultivated	Upland	Yes	5.97	1.83	1.06	0.45	4.27	2.8	0.73	0.26	0.39	0.99	186	0.3	6.8
Emitsundandan	0-15	Fallow	Lowland	No	5	1.09	0.63	0.49	4.34	0.7	0.62	0.34	0.22	1.34	309.5	0.3	0.6
	15-30	Fallow	Upland	No	6.3	0.95	0.55	0.33	2.84	0.49	0.42	0.2	0.44	0.12	166.9	0.3	0.6
Emitsundandan	0-15	Cultivated	Lowland	Yes	4.97	1.4	0.81	0.53	5.01	1.7	0.65	0.17	0.27	0.28	127.31	0.4	9.1
	15-30	Cultivated	Upland	Yes	6.13	0.9	0.52	0.3	5.18	1.36	0.36	0.3	0.36	1.02	197.8	0.2	1
Emitsundandan	0-15	Fallow	Upland	No	4.9	0.86	0.5	0.32	6.18	1.05	0.61	0.14	0.25	0.93	316.6	0.7	1.6
	15-30	Fallow	Upland	No	6	2.07	1.2	0.14	13.28	0.35	0.44	0.12	0.24	0.16	159.7	0.1	4.1

Appendix Table 3: Plant and processing dust analysis of selected rice growing locations

State	Location	Ecology	Fertiliser Use	%N	%P	%K
Niger	Ejeti	Flood plain	Yes	0.91	0.10	4.00
	Emitsndandan	Flood plain	Yes	0.53	0.04	2.71
	Boku	Flood plain	Yes	0.59	0.04	1.61
Ebonyi	Abakaliki	Lowland	Yes	1.32	0.08	2.84
	Abakaliki	Lowland	No	0.58	0.07	1.75
	Abakaliki	*Lowland	No	0.91	0.07	2.61
	Abakaliki rice mill processing dust (Fresh)			0.13	0.12	11.52
	Abakaliki rice meal processing dust (Stale)			0.11	0.08	17.01

Note: * Lowland rice field cultivated for the first time after long fallow.

Appendix 2: Potential of area expansion and technical change by ecology

		Mangrove Swamp	Deep-Water/ Floating	Irrigated Lowland	Rainfed Lowland	Rainfed Upland
Short term	**Area expansion potential**	Very limited	None	Rehabilitation	High	Medium
	Intensification	Varieties	None	Varieties Crop Management		NERICA
Long term	**Area expansion potential**	None	None	Possible	Decreasing	Decreasing
	Intensification	Crop management	None		Varieties	Crop Management

Source: Osiname, 2002.

Appendix 3: Major river basin development authorities and other irrigation projects in Nigeria

No	Project Name	RBDA	Reservoir Storage Capacity Mca	Irrigation Potential (ha)	Irrigation Completed (ha)	Functioning Status
1	Lower Anambra	Anan-Imo	Pumping	4,200	4,200	Fully
2	South Chad	Chad	Pumping	67,000	18,000	Partial
3	Baga Polder	Chad	Pumping	20,000	1,724	Partial
4	Alau Dam	Chad	122	8,000	-	Nil
5	Jere Bowl	Bo ADP	-	20,000	5,000	Partial
6	Tiga Dam/Kano River	HJRBDA *	1975 -	22,000(1) 40,000	15,000 Nil	Fully Nil
7	Challawa Gorge Dam	*	1970	12,500	Nil	Nil
8	Calala Dam	*	21	2,000	Nil	Nil
9	Watari	KNARDA	-	700	700	Fully
10	Tomas	KNARDA	-	200	200	Partial
11	Bakolori Dam	Sokoto-Rima	450	23,000	23,000	Nil
12	Goronyo Dam	*	942	33,000	-	Nil
13	Zobe Dam	*	170	8,000	-	Nil
14	Jibiya Dam	*	142	2,860	-	Nil
15	Doma Dam	Lower Beneu	28	2,000	2,000	Partial
16	Tunga Kawo	Niger River	22	800	800	Nil
17	Kubil Dam/Swashi	*	70	5,300	-	Nil
18	Dai Dam	*	220	5,000	-	Partial
19	Badeggi	Niger ADP	-	800	800	Partial
20	Edozhigi	*	-	400	400	Partial
21	Agaei/Lapai	*	-	250	250	Partial
22	Rabbah	*	Pumping	2,000	1,500	Nil
23	Kiri Dam		325	12,000	6,000	Nil
24	Dadin Kowa	Upper Benue	2,855	44,000	300	Nil
25	Ikere Gorge Dam	*	565	12,500	-	Nil
26	Itoikin	Ogun-Osun	270	12,000	-	
27	Adani Rice Project	*	2,500	5,000	-	
28	Peremanbere Rice Project	HJRBDA	Pumping		314	
29	Nigerian Bottling Company, Rice Project, WAPPA, Agenebode.	Ogun-Osun				

Source: Osiname (2002).

Appendix 4: FAO recommended maximum concentrations of the elements in irrigation water

Element	Maximum Concentration
Al	5
Arsemid (AS)	0.1
Boron B	1
Cadmncd	0.01
Cu Cn	0.2
Fe fe	5
Lead Pb	5
Mn	0.2
Mo	0.01
Se	0.02
Zn	2

Source: Osiname, 2002.

Appendix 5: WHO guidelines for drinking water quality (1984)

Parameters	Value	Source	Frequency
Inorganic Constituents (mg/l)		*WHO Guidelines for Drinking Water Quality (1984)*	
Aluminium (al)	0.2	N	*
Ammonium (NH_4^+)	0.01	Pn	**
Arsenic (As)	0.05	Np	**
Cadmium (Cd)	0.005	P	*
Chloride	250.0	NP	***
Chromium (Cr)	0.05	P	**
Copper (Cu)	1.0	Np	*
Cyanide (CN)	0.1	P	**
Detergents	0.2	P	**
Fluoride (F)	1.5	N	**
Iron (Fe)	0.3	NP	***
Lead (Pb)	0.05	Np	*
Manganese (Mn)	0.1	NP	**
Mercury (Hg)	0.001	Np	***
Nitrate ($N0_3$-N)	10.0	Pn	***
Selenium (Se)	0.01	Np	*
Sodium (Na)	200.0	Np	***
Sulphate ($S0_4^{-2}$)	400.0	Np	***
Zinc (Zn)	5.0	Np	**

Notes: Capital letters indicate more frequent occurrence
N: naturally occurring, P: human-made pollution

Source: Osiname; (2002).