RICE FOR FOOD
MARKET AND DEVELOPMENT.

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5. The National Cereals Research Institute, Badeggi, Niger State.
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Our special gratitude goes to all members of the National Organising Committee, the technical personnel and staff of rice - Africa. We also wish to thank all the participants, whose presence made the International Conference a huge success.

Dr. E.E. Idu
rice-Africa

PREFACE

Rice is the most rapidly growing source of food in Africa and is of significant importance to food security in the continent. The demand for rice in Africa continues to outstrip production, with the continent importing nearly 10 million tonnes of the product annually. Although there are rice development programmes in several African countries, this demand-supply gap widens yearly. In most African countries, emphasis in rice programmes has been more on increasing yield and enhancing stress tolerance.

The emerging opportunities in Africa's rice economy demand that rice farmers, processors, marketers, researchers and all stakeholders in Africa's rice sub-sector are provided with current technical information on the industry, from field to table.

The rice-Africa 1st International Conference on rice for Food, Market and Development was held between 3 – 5th March 2011 at the Raw Materials Research and Development Council (RMRDC), Maitama, Abuja, focussing on the value chain (from field to fork) and the links between firms, supporting service providers and its regulatory environment, with participants drawn from Asia and Africa.

This event offered a unique opportunity for rice stakeholders to provide responsive information and create synergies to support the rice sector, increase farmers/processors income and stimulate interventions to increase competitiveness.

It is our hope that the rapid adoption of options and techniques proffered in this important resource book will increase local production, processing and foster the equitable integration of small-scale rice enterprises into market-oriented systems. This will not only lead to reduction of rice imports and foreign exchange savings in the continent but will more importantly lead to increase in job creation for the rural folk, increase in rural income and reduction in poverty levels.

Dr. M.A. Jolaoso
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FOREWORD

The importance of rice in the economy and diet of several African countries cannot be over emphasized. Africa is blessed with abundant natural resources as well as suitable ecology for rice production and appropriate technologies for its processing. In spite of these, the continent still cannot meet its local rice needs and expends huge foreign exchange on importation.

There are many factors contributing to the inability of Africa to achieve the desirable self-reliance in rice production and processing. One major factor that could stem this tide is to improve the cultural practices in the production technologies of the commodity. The "Sawah" system of rice production which was demonstrated to stakeholders during this conference is a joint initiative between the Soil Research Institute (SRI) of the Council for Scientific and Industrial Research (CSIR), Ghana and the Shimane/Kinki Universities, Japan. The project started in 2002 under the leadership of Professor Toshiyuki Wakatsuki. Its main objectives are to encourage and promote collaborative scientific research between the two institutions and to serve as a back-stocking mechanism for the transfer of the "Sawah" technology, after the main JICA/CSIR Joint Project ended in 2001.

The hosting of the International Conference on the theme "Rice for Food, Market and Development" by the Raw Materials Research and Development Council (RMRDC), Abuja, organised by rice Africa could not have come at a better time than now, when the Federal Government of Nigeria is seriously pursuing the quest for self-sufficiency in rice production.

It is hoped that the transfer of the "Sawah" production techniques and adoption by African rice farmers, will lead to increased production to hasten the continent's self-sufficiency in food production.

Engr. (Prof.) Azikiwe P. Onwualu, FAS.
DG/CEO (RMRDC).

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**WELCOME ADDRESS
BY
PROF C. P. O. OBINNE**

Human population growth, increasing urbanization and rising incomes are causing a rapid dynamic increase in the consumption of rice in Africa. The demand for rice in Africa continues to outstrip production with, the continent importing nearly 10 million tonnes of the product annually. Although there are rice development programs in several African countries, this gap widens yearly.

In most African countries, emphasis in rice programmes has been more on increasing producer's yield to the detriment of postharvest chains (including processors, traders, merchants, exporters, facilitators and other rice service providers). The reasons for this state of affairs include the lack of appreciation of the importance of value chain development, the inefficient rice service delivery, coupled with the absence of personnel with the requisite knowledge in many African countries. Consequently, 15 – 25% of rice harvest is still lost in inefficient postharvest chains. Rice varieties are developed, field tested and released without reference to their milling potentials. Consumer acceptability trials, quality development and quality assurance, grades and standards, product labeling, packaging adaptation and certification schemes are also often not carried out. As a result, lower prices are paid for locally produced rice, reducing the incentive for local production and consequently the success of the African rice industry. In addition, farmers and the industry are losing out on potential income because of delays in postharvest operations, outdated postharvest technology and limited access to quality markets.

In spite of these trends, the majority of rice currently consumed in African countries is still produced by semi-subsistence farmers. The growth in demand for rice therefore offers a unique opportunity for the African producers, since they have a significant stake in rice production. In addition, it presents one of the few rapidly growing markets that poor people can join.

Besides the opportunities that arise from the growing demand for rice, African rice producers are also facing the threats from the resulting transformation of rice sector. A rising demand for rice provides an economic incentive for the application of intensive production systems, through which rice can be produced much cheaper than by small-scale farmers. However, increasing regional and rural-urban inequity is threatening continued economic progress and food quality and safety have increasingly been a major concern of consumers. These challenges combined with globalization are having a profound effect on rice production and marketing of the smallholders in Africa. The rice sector in Africa will have to cope with such and new challenges that relate to the sustainability of rice production, farmer's livelihood and rural development. As a result, the attributes of many indigenous rice systems will need to change and availability and access to, appropriate and affordable rice service delivery will be one crucial element, if Africa rice industry are to meet the requirements of these new markets.

There is an urgent need, therefore, for a change in rice production practices from a local multi-purpose activity to an increasing market-oriented and vertically-integrated business and to build skills and technologies that improve efficiency and productivity along value chains as a complement to the support being provided to increase productivity in primary production.

In the past decades, national and international organizations have conducted a number of research and development programmes to address these problems and challenges in several Africa countries and it is thus timely to review the activities conducted by national and international agencies.

The objectives of this conference are to:

a. share the lessons learnt from research and development programs conducted on rice production, processing and marketing
b. discuss new ideas and innovative approaches relevant to the delivery of rice value chain
c. discuss rice service research and development strategies that meet the changing needs of smallholder rice farmers under a range of rice sector development scenarios.

Output and impacts

The output from this conference will have considerable impact on government policy and R&D, as well as private sector initiatives relevant to reduced inequity through enhanced economic opportunities for rice farmers, processors, traders and service providers in Africa. This will also be an opportunity to assess the ways in which international organistaions can effectively participate in and contribute to rice-industrial development in Africa.

WE WELCOME YOU ALL TO A WONDERFUL DELIBERATION THAT WILL CREATE SYNERGIES TO SUPPORT THE RICE INDUSTRY IN AFRICA.

THANK YOU

PROF C. P. O. OBINNE
Chairman, National Organizing Committee

ENABLING POLICES AND SECTOR STRATEGIES AND PLAN FOR RICE: THE NIGERIAN EXPERIENCE

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1.0 INTRODUCTION

Nigeria's population is about 140million, which constitutes one fifth (1/5) of the total population of sub-Saharan Africa. Thirty seven percent (37 %) of these people live in urban areas, while the remainder, who live in the rural areas, are dependent on smallholder agriculture. Agriculture is vital to Nigeria's economy, in spite of the dominance of petroleum. It is the largest non-oil export earner, accounting for 88 percent of the non-oil foreign exchange earnings.
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Agriculture holds the key to rapid economic development, social transformation and poverty alleviation. It accounts for 42% of the nation's Gross Domestic Product (GDP) and offers employment to about 80% of the population. In spite of this, agricultural production has failed to meet the food needs of the country's rapidly growing population. This has led to constant food shortages, rising farm product prices and huge importation of food by the government. The poor performance of Nigeria's agriculture is as a result of the system of production characterized by small and uneconomic production units, fragmentation of land holdings and predominance of poor management of production techniques. Other issues negatively affecting agriculture are inadequate credit facilities, low capital investment with low productivity and income to farmers.

The rice crop is of strategic importance worldwide. It is a major commodity in world trade. Rice is the second most important cereal in the world after wheat in terms of production. Rice feeds at least half of the world's population. It is also the most important staple food for half of the human race. The United Nations (UN) declared the year 2004 as the international year of rice during the 57^{th} session of her General Assembly. This was the first time that any commodity would be accorded such recognition. In sub-Saharan Africa, West Africa is the leading producer and consumer of rice. It accounts for 64.2% and 61.9% of total rice production and consumption in this sub-region, respectively.

Globally, rice production has been increasing since the 1960s. From 1965 -1979, the areas cultivated to rice increased from 124 million hectares to 145 million hectares, while output rose from 253 million tonnes to 380 million tonnes. This indicates an increase of 16%, 50% and 31% in area, output and yield, respectively. Rice yield improved from 2 tonnes ha^{1} in 1961 to over 4 tonnes ha^{1} In 1965. The area cultivated in 1989 was 146 million hectares and the grain harvested was 506 million tonnes. This represents 33% increase in production. Increase in area cultivated was less than one percent but there was tremendous increase in the output per hectare (yield) of 3.5 ton ha^{1}. This performance was attributed to the green revolution in Asia, Europe and Latin American through the adoption of modern cultivars, that is, the high yielding varieties (HYV).

Nigeria plays a leading role in rice production in West Africa. It is both the highest producer and consumer of rice in the Sub-region, with figures slightly above 50%. Increase in rice consumption in Nigeria was attributed to rapid population growth, urban residents' exposure to dietary patterns of foreign cultures, urban lifestyle with preference for foods which require less time to prepare. These factors and rising household income of the urban population have influenced the pattern of rice consumption Rice consumption pattern has been changing over the years. The annual rice consumption in 1960 was 3 kg per capita; it increased to 18 kg in 1980. It averaged 22 kg between 1995 and 1999.

The rate of increase in consumption between 1995 and 1999 was more than double the population growth rate of 3.5% per annum. In 2005, the average Nigerian consumed between 24-28kg of rice per year. This represents about 9% of total calorie intake. Between 1961 and 2002, rice production increased at an average rate of 11.8% per annum. Yield however, grew at a lower rate of 3.19%. This suggests that the growth in production was due to expansion in the harvested area. However, rice yield per hectare averaged only 1.74 tonnes throughout the period. National rice production between 2002 and 2004 was 3.065 million metric tons, while demand was about 5.0 metric tonnes. In spite of the increase in production of about 1.8%, the demand for rice outstripped supply, consequently the country has been importing to bridge the demand-supply gap.

Rice importation into Nigeria was very low in the 1960s. It rose from 1,100 tonnes in 1961 to 594,057 tonnes in 1995. It was 687,925 tonnes in 1999, representing an estimate of $259million in scarce foreign exchange for that year. This rose to $655 million and $756 million in 2002 and 2003, respectively.

Nigeria alone accounted for 3% of the value of rice imported into West Africa. This constitutes a huge drain on Nigeria's foreign reserve and a major bottleneck in her balance of payments. Nigeria has become a major rice importer in the world and only second to Indonesia. If placed on a social scale, it ranked first, because it is no longer a festival meal but the most important staple food in urban and rural areas. It is also very important economically. Increasing domestic rice production to satisfy the growing rice consumption and reduce import has become a top priority of the Nigerian government.

Past and present Nigerian governments have made deliberate efforts through different policy measures, strategies and plans to encourage the production and marketing of rice in the country. Some of these measures will be discussed in this paper. 2.0 National Rice Economy and Relevant Policy Issues

The policy measures which the Nigeria government has employed can be categorized into three, namely macro-economic policy, investment policy and price policy. The macro-economic policies are fiscal, monetary and exchange rate policies.
The investment policies included pronouncement that established rice research and technology development activities and institutional development programmes. While the investment and macro-economic policies are applicable to all crops, the price policy is specific to the rice sector alone.

2.1 INVESTMENT AND MACRO-ECONOMIC POLICIES:

From the 1970s to date, many investment policies have been put in place. These include the establishment of a Rice Research Station at Badeggi, Niger State. This later metamorphosed to National Cereals Research Institute (NCRI). Investments were made in rice research, resulting in the development and release of 57 rice varieties. NCRI has developed improved rice technologies, which have been disseminated to farmers through the Agricultural Development Programmes (ADPs).

Other programmes put in place to improve the production, processing and marketing of rice include:

- The National Accelerated Production Programme (NAFPP -1976)
- Operation Feed the Nation (OFN,1976-1979)
- Agricultural Development Programmes (ADPs, 1975 to date)
- The Green Revolution (1979-1983)
- National Rice Production Programme (1986)
- The Associated Rice Programmes under the River Basin Development Authorities (RBDA, 1977) and Nigerian Grains Production Company
- Back to Land Programme (BLP, 1983-1985)
- Directorate for Food, Roads and Rural Infrastructures (DFRRI,1985-1992)
- The Special Rice Production Programme-Japanese Grant- In-Aid (1998 to date) and,
- National Land Development Authority (NALDA, 1995).

Other programmes that have relevance to the development of the rice sector include:

i. Family Economic Advancement Programme (FEAP, 1994),
ii. National Agricultural Research Project (NARP, 1995).
iii. The Special Rice Project (SRP, 1998),
iv. National Fadama Development Project (NFDP, 1999).

Other policies included the Structural Adjustment Programme (SAP) which focused on the role of market forces to direct the economy. Before SAP, the exchange rate and foreign exchange allocation depressed farming. The nominal exchange rate was kept constant in a situation where the price level was relatively stable internationally and inflation was rising locally. Consequently, the local currency was over valued between the periods of 1970 and 1975 by 100%; from 1976 to 1979 and 1980 to 1985, the Naira was overvalued by 200% and 700-900%, respectively. The over-valued exchange rate of the Naira made imported rice cheaper than local rice and these implicitly taxed domestic rice producers.

2.2 PRICE POLICY:

The price policies used by the government were quantitative restrictions (import restriction, tariff and subsidies) and ban on rice importation. The government imposed a 66.7% tariff on imported rice in 1974 but by 1978 this was reduced to 17%. From 1980 -1984, import licences were issued with no quantitative restriction. There was an out-right ban on rice importation in 1979 for 6 months and between October 1985 and July 1986. The use of tariff was resumed in 1975. In 2002 the tariff was 100%.

2.3 POLICY ON FERTILIZER:

Fertilizer has become a political commodity in Nigeria, while policy with respect to it has remained unstable over time. Nigeria depends on fertilizer import to sustain agricultural production in the country. Prior to 1999, fertilizer trade and distribution was completely liberalized.By 2000, there was an imposition of 25% subsidy. The current situation is that the 25% is still being retained by the Federal Government, while most states of the Federation (particularly, the North) also put in additional 25% subsidy to assist farmers. With respect to other agricultural inputs, the current situation is that government had reduced the import duty from 5% (prior to 2003) to 0%. The same goes for rice processing machines.

2.4 OTHERS:

Prior to 1999 there was no specific policy targeted at rice farmers, even though there was a general agricultural guaranteed scheme which every farmer including rice farmers are supposed to benefit from. Currently 5% tariff on rice import is now set aside for rice sector development. In addition 50 billion Naira was also set aside under the Presidential Rice Initiative as a revolving loan to rice farmers through the National Agricultural Credit and Rural Development Bank (NACRDB), now Bank of Agriculture (BOA).

A policy that stresses the importance of ensuring adequate supply of good quality seeds at affordable prices is currently in place. The major objective of the policy is to provide a framework for future development of the seed sub-sector. In the implementation of the Presidential Initiative, the sum of one billion Naira was released by the Federal Government for the multiplication of seeds of NERICA and other improved rice varieties.

3.0 NATIONAL RICE DEVELOPMENT STRATEGY (NRDS) FOR NIGERIA

Nigeria is committed to the achievements of national food security. In the quest for self sufficiency in food production and recognizing that rice has now become a major staple and cash crop, the Federal Government of Nigeria embraced the Coalition for Africa Rice Development (CARD), an initiative for doubling rice production in sub-saharan Africa within the next ten (10) years. This initiative was jointly developed by the Alliance for Green Revolution in Africa (AGRA) and Japan International Co-operation Agency (JICA). It is being implemented in full based on the Comprehensive Africa Agriculture Development Programme (CAADP) with strong links to existing structures, programmes, network and institutions such as Forum for Agricultural Research in Africa (FARA) and the Africa Rice Initiative (ARI). Nigeria has embodied the CARD initiative, with the ultimate aim of mapping out the National Rice Development Strategy (NRDS) as a framework of action of doubling rice production. The initiative aims to respond to the increasing importance of rice production in the country and proposes to re-appraise the rice sector of the economy and building on the strength of existing structures, policies and programmes to promote and improve rice productivity and market competitiveness in Nigeria.

3.1 GOALS AND PRIORITIES OF NRDS

The goal of the NRDS is to increase rice production in Nigeria from 4.2 million tonnes paddy in 2008 to 12.85 million tonnes by the year 2018. The NRDS has the following priorities: post-harvest handling and processing, land development, irrigation development, seed development and other production inputs.

3.2 NRDS STRATEGIC PLANS AND VISION

The NRDS plans to articulate the following activities:

i) Provision of technical assistance: Provision of technical assistance to National Agricultural Research Institutions e.g. NCRI, the National Agricultural Seeds Council (NASC) and the Community Based Seed Production System, for the production of quality breeder, foundation and certified seeds, respectively. Hybrid rice varieties and biotechnology will also be used to increase rice production to the vulnerable rice farmers.

ii) Agro-chemicals: Agro-chemical supply, handling and application inputs such as seeds, will be subsidized and chemical fertilizer will be made available at affordable prices. Organic fertilizer use will be encouraged and promoted

iii) Fertilizer marketing and distribution: This will be strengthened by making the private sector the driving force behind the marketing and distribution of the product. Local production of fertilizer will be increased to make it easily available and affordable.

iv) Agricultural Mechanization: This will minimize drudgery and facilitate commercialization of rice products.

v) Post-Harvest handling, processing and market: This will be improved through trainings. Comprehensive rice processing mills will be established. Standard grading and branding of domestic rice will be pursued and implemented.

vi) Marketing: Distribution networks of locally processed rice,domestically and internationally will be improved.

vii) Access to Credit and Finance: Lending to stakeholders in the 'Rice Value Chain' will be improved in a timely and adequate manner.

viii) Extension Services: Provide adequate funding and incentives to extension services to the benefit of both small and large scale farmers.

ix) Policy: Create better policy environment for rice sector development. In furtherance of the above strategic plans and vision, the following activities have been developed by the Federal Government in pursuit of its 7 Point Agenda towards the attainment of the Millennium Development Goals (MDGs):

i) Establishment of 17 large scale integrated rice mills in the major rice producing areas, under the Public Private Partnership (PPP) arrangement.

ii) Rehabilitation of two (2) large rice processing mills in Niger and Anambra States under the PPP arrangement, with the capacity of 30,000 tonnes and 15,000 tonnes/per annum, respectively.

iii) Establishment of an integrated rice processing complex at Bida, Niger State by Korean International Co-operation Agency (KOICA), a technical assistance to Nigeria that is still in progress.

iv) Establishment of an out-grower scheme at Badeggi, Niger State, with 3,000 registered farmers through a macro-finance arrangement.

v) Expansion of the National Strategic Grain storage capacity nationwide, comprising storage silos. This is to store paddy rice for the processing plants in the country all year round.

vi) Land and Irrigation Development through the rehabilitation of the 11 irrigation schemes in the country and allow them to be operated on a PPP basis for efficient management. Land clearing to expand hectarage under rice production will be pursued.

vii) Project Management- This will include co-ordination and close

Monitoring and Evaluation (M&E), to obtain feedback on the implementation of the activities. A National Co-ordinating Committee involving representatives of stakeholders and donor agencies will be set up to guide and monitor the NRDS in Nigeria.

3.3 RECOMMENDATIONS OF STAKEHOLDERS FORUM ON NRDS DOCUMENT.

i.) In discussing the "Rice Value Chain" approach as elucidated in the document, participants during a two-day stakeholders forum at Abuja in December 2010, recommended formation of the following Committees for proper, practical and timely solutions to the key constraints in the funding of rice industry, access to credit, rice post-harvest handling, processing, marketing, mechanization and provision of production inputs:

   a) Committee on Rice Post-Harvest Handling, Processing, Quality Assurance and Marketing.

   b) Committee on Finance and Access to Credit

   c) Committee on Mechanization

   d) Committee on Production Inputs

ii.) Government should through the Commodity Exchange, improve paddy rice marketing to ensure constant supply of raw materials to processors all year round.

iii.) Government should expedite action on the completion of all silos under construction and set aside substantial storage space for the procurement of paddy from rice farmers all over Nigeria and release same to processors later in the year with guaranteed price support.

iv.) Investment promotion incentives should be included in the NRDS document as priority by eliminating multiple taxes on capital, to encourage investment in the "Rice Value chain"

v.) Government should urgently harmonize tariffs and duties payable on imported rice as well as institute a firm import levy, to protect and encourage domestic investment in rice production and processing.

vi.) The On-going "Rice Mapping" being carried out by USAID-MARKETS should be concluded to facilitate market information to investors and traders in the "Rice Value chain'

vii.) Government should create enabling environment to improve power generation, distribution and supply in the country to drive rice production and processing.

viii.) Government should scale up investment in the provision of infrastructure (roads, rails, in-land water ways, processing factories and marketing outlets) required for the promotion of high quality rice with good market competitiveness.

ix.) Advocating groups should be constituted to champion the current national orientation and attitude, publicity, support and implementation of NRDS, covering government donor agencies, development partners and non-governmental organisations (NGOs).

x.) A national quality standard for rice should be developed and adopted nationwide.

4.0 CONCLUSION

There is hope and opportunities to improve rice productivity, processing and marketing in Nigeria. Nigeria has adequate human and natural resources to grow rice, process and feed itself. Thus, there is the need to address the fundamental problems facing the rice sector generally, such as effective political will for effective policy implementation adoption and use of appropriate technologies, improved infrastructure and distribution, quality processing, creation of marketing outlets, access to credit facilities and insurance on agricultural enterprises. There should be effective Monitoring and Evaluation (M&E) of activities for effective feedback on compliance and implementation of set goals and objectives. The problem of Nigeria is not policy formulation but implementation and budget discipline.

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PUBLIC -PRIVATE PARTNERSHIP (PPP) FOR ACCELERATED DEVELOPMENT

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1.0 INTRODUCTION

Rice is the second largest produced cereal after wheat in the world. At the beginning of the 1990's, annual production was around 350 million tonnes and by the end of the century it had reached 410 million tonnes (FAO). The world output of rice has been on the decline since the end of the previous millennium and this is explained by the strong pressure put on land and water resources which led to a decrease of seeded areas in some Western and Eastern Asian countries who were major producers of rice.

Production of rice is geographically concentrated in Western and Eastern Asia, with more than 90% of the world's output. World production of rice has shown a significant and steady growth almost exclusively due to increasing production in these areas.

International rice trade is estimated at 25 – 27million tonnes per year corresponding to only 5 – 6% of world production (FAO). This makes the international rice market one of the smallest in the world compared to other grain markets such as wheat (113million tonnes and maize 80m tonnes).

In Africa, the demand for rice is more than production and this account for the huge importation of rice running into billions of dollars. Despite various rice development programmes embarked upon by several African countries, rice importation to bridge the gap between demand and supply widens on yearly basis. This ugly trend is caused by a number of factors namely:-

(i) Emphasis on increased rice production without corresponding adequate post harvest management that would produce rice that can compete favourably with the imported rice;
(ii) Lack of value addition development.
(iii) Lack/inadequate infrastructure such as electricity, modern mills etc;
(iv) Lack/inadequate funds to procure inputs (seeds, fertilizers, Agrochemical etc);

(v) Lack/inadequate working capital;

(vi) Lack of personnel to operate and maintain modern mill where available;

(vii) Politicization of rice policy by Several African Government; and

(viii) Bulk of rice output in Africa are produced by small scale farmers and of different varieties which does not allow efficient processing of high quality standard rice that can compete favourably with imported rice.

These identified problems required huge resources to be adequately addressed for efficient rice industry. The resources needed is beyond most and if not all African governments due to scarce resources and other competing sectors.

The private Sector that are better positioned financially to handle high profile investment like the one required for effective rice industry in Africa would only invest in less risky and high profit making project which the rice industry and agricultural projects in general could not provide. As such, there is the need to strike a balance between the Public Sector that is weak and inefficient project management capability and the private sector that has experienced financial capability and profit orientation to partner in order to provide the much needed infrastructure for accelerated rice development.

Hence, the concept of Public Private Partnership (PPP) Initiative is more relevant for accelerated rice development in Africa.

2.0 PUBLIC PRIVATE PARTNERSHIP CONCEPT:

The Public Private Partnership (PPP) concept is a means to bring the best features of the public and the private sector together. The private sector can make available its advantages in creative financing, operational efficiency, lower cost of distribution, more efficient decision – making process, management flexibility and its effective handling of complex delivery system. The public sector on other hand can provide strategic direction in areas of policies, choice and location of infrastructure, ensure value for money and transparency in procurements and above all, provide capital or user fees subsidies, or commitments to purchasing agreements to ensure that the private firms enter large markets with guaranteed consumers.

It is participation by the private sector (for profit or not-for-profit sectors) in the provision of infrastructural services in cases where, if left to the free market alone such participation would not occur because of the low returns it provides on investment or the high level of risk involved, financial or non-financial. It therefore involves an element of risk sharing between the public and the private sectors

.

The main variables involved in formulating a PPP arrangement in the context of providing infrastructure for agricultural development include:-

- Strategic Infrastructure Planning for Agricultural Development
- Commercial Viability and Value for Money
- Division/Sharing of Risk
- Contractual Arrangements and
- Institutional and Support Mechanisms

There are numerous infrastructure constraints facing resource poor rice farmers to sustain growth of the sector, these include transportation, energy and telecommunication. These deficiencies normally lead to high business transaction costs, poor spatial integration, poorly financed domestic markets, weak international competitiveness and low priced paddy. The productivity challenge will involve investment in physical infrastructure to improve the output per worker, inward investment in technology or more efficient production, leading to high output per unit area or time.

The alternative to this strategy is to invest in social infrastructure, with the ultimate goal of improving the living standard of the rural poor. This will ultimately improve rice productivity; the provision of more efficient and affordable basic household services like water and sanitation, household electricity, access to affordable health care, basic education, public transportation service are likely to improve the productivity of farmers, farm workers and managers.

The private sector participation could focus either on the farm level e.g. irrigation to support out-of-season cropping or on processing paddy.

Rice processing is often viewed as essentially a private business. The public sector should be seen to be involved in contributing to this sector in form of land through concessions, or provide capital grants, as has been done by FGN 10 billion rice processing intervention fund. The situation where rice farmers are able to raise their own capital to finance new or expanded rice mills, depend solely on rice paddy which is grown by small scale farmers who carriesa high level of rice production risk. Capital subsidy from the state in form of land or grants should be part of the solution. Significant improvement in rice farmers' income can be achieved without increasing rice productivity, if post harvest storage, trading and transportation costs are significantly reduced.

The difficulty in the procurement or access of post harvest storage facilities for rice farmers is a significant constraint in rice development in Nigeria. In the same way, lack of market exchanges and auction centres to improve margin for farmers and farmer cooperatives and to bring economics of scale to the provision of rice seeds, fertilizer and other agricultural inputs, is a major constraint. Low levels of investment in irrigation is also a major constraints for the dominantly rain fed rice production in Nigeria.

The importance of reliable and affordable electricity to support investment in irrigation or rice processing facilities and the need for good rural roads, if investing in rice mills that rely on regular deliveries of paddy from numerous out-growers, is to succeed.

The public sector in the Public Private Partnership (PPP) Concept includes those that lend or make grants to governments, bilateral and multilateral Development Finance Institutions etc. A key element of PPP is deciding how commercial risk of recovering the service fee is to be allocated between Public and Private arrangement namely:-

(i) The Private sector is paid directly or indirectly through various forms of state guarantees, regardless of the level of user- demand, thus leaving the commercial risks with the state.

(ii) The Private sector provider is paid according to operational results, either directly by the level of end user demand or indirectly through performance-based subsidies from the public sector and here the private sector faces the main commercial risks.

* In low-income economies, support to finance medium term development instead of long term development such as provision of infrastructure from international development agencies, are given more attention by such economies.

* In emerging African economies, public investment policies for production are concentrated in the urban rather than rural areas, where serious agriculture takes place.

* Low administrative efficiency of public service departments leading to poorly planned, designed, financed, poor recovery rates and inadequate maintenance culture for capital infrastructure projects.

* User tariffs set are too low to cover operational costs or payback capital investments for either political reasons or due to inaccurate assessment of risks.

* Mismanagement and misconception especially in the process of procurement of infrastructure engineering, construction and maintenance services.

* Underdeveloped domestic engineering sector to operate, maintain and repair capital infrastructure.

4.0 REASONS FOR PRIVATE SECTOR NOT WILLING TO PARTICIPATE OF THE PROVISION OF AGRICULTURAL INFRASTRUCTURE:

In the past decades, market-oriented economic reforms have attempted to stimulate provision of developmental infrastructure through the private sector, with cost recovery through tariffs. These reforms successed in the telecommunication and power sectors, in particular. However, private sector operators are still skeptical in commiting their investment in rural areas infrastructure, where agricultural activities take place. The reasons for this skepticism, is that investment in public infrastructure in remote rural areas are commercially not viable in terms of cost recovery, because of vagaries which agriculture is exposed to and other socio-cultural influences. These risks means that revenue flows from infrastructure user fees can be highly unpredictable.

5.0 WHAT MOTIVATE PRIVATE SECTOR TO INVEST IN PROVISION OF INFRASTRUCTURE:

In strategic planning of market-oriented agricultural infrastructure, the private sector is interested in recent commercial viability or whether the proposed infrastructure offers growth potential and whether it offers potential for design innovation and operational changes to raise current levels of public sector efficiency.

6.0 WAY FORWARD

In the rural areas, dominated by subsistence agriculture, low population densities, low levels of household capital accumulation and savings, large numbers of farmers cannot afford to pay users fees, if these include the recovery of costs for construction of infrastructure assets. In these cases, if a private firm is ready to provide the public services for reasons of efficiency, some form of alternative capital cost recovery mechanism will be needed. This could be a state or donor subsidy or some indirect revenue stream.

For many poor communities, it is not only the recovery of capital expenditure for infrastructure that is the only problem but also long term operating and infrastructure maintenance costs. These financial constraints mean that financing for agricultural infrastructure frequently needs to combine public and private financing.

The United Nations (UN) sponsored financing for development conference in Monterrey in 2002, concluded that new and greater cooperation between public and private sectors would be required to overcome the identified inadequacies to current development finance to achieve the internationally agreed development goals.

In line with this, in July, 2005, Leaders of Group of Eight industrial nations summit in Gleneagles, called for the use of PPP mechanisms in Africa to increase direct investment in infrastructure and utilize market incentives. With the PPP arrangement, the much needed capital for accelerated rice development can be achieved, as well as providing guarantee for envisaged risks in the investment process.

DEVELOPMENT PARTNERSHIPS IN PRACTICE: THE SAWAH TECHNOLOGY

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ABSTRACT

This paper examines the process of technology development and dissemination with respect to Sawah rice production. The term "sawah" refers to man-made environment for rice production that includes levelling and bunding of rice fields with inlet and outlet connecting irrigation and drainage. It has been hypothesized that Sawah rice production technology holds the ace to the expected green revolution in West Africa, as yields of 5t/ha have been obtained. The process of sawah rice technology development and dissemination is exploring strategic synergy and partnership among Japanese institutions, research institutes, Ministry of Agriculture, extension agencies, farmers groups, Millennium Village and Universities in Nigeria and Ghana, which can be described as an emerging innovation system for rice production in West Africa.

The partnership was empirically ascertained in terms, kind and intensity of involvement of the various stakeholders in the areas of joint problem identification (JPI), joint priority setting and planning (JPSP), collaborative professional activities (CPA), joint On-farm Adaptive Research (OFAR), dissemination of knowledge (DK), joint demonstration trials (JDTR), joint field days (JFD), joint seminar and workshop (JSW), evaluation survey (ES) and evaluation meeting (EM). A structure questionnaire was used to elicit information from a list of activities identified among the stakeholders. Data collected were subjected to percentage distribution and one-way analysis of variance to determine differences in the involvement of each of the actors. The results show varying degrees of involvement, types of involvement and different levels of intensity. While Japanese institutes are very prominent in funding and training, scientists and farmers are prominent in problem identification and joint demonstration trials. The implications of the results are discussed and pragmatic suggestions made for a proactive revamping of the process of technology development and dissemination for rice production in West Africa.

INTRODUCTION

Over the decades, rice has occupied a prominent position as a strategic crop for food security and economic development of nations of the world. FAO (2006) classified the crop as the most important food depended upon by over 50 percent of the world population for about 80% of their food need. Due to the growing importance of the crop and the increasing challenges of attainment of food security, it has been estimated that annual rice production needs to increase from 586 million tonnes in 2001 to meet the projected global demand of about 756 million tonnes by 2030 (Kueneman 2006). Recent global trend in the rice industry however shows that there is a growing import demand for the commodity in Africa, as evidenced from pressure on world supply and the steady increase in world price of the commodity in the last five years (FAO, 2006). In the West Africa sub region, Nigeria has witnessed a well established growing demand for rice as propelled by rising per caput consumption and consequently the insufficient domestic production had to be complemented with enormous import, both in quantity and value at various times (Erenstein., 2004; Daramola, 2005). The enormous importation has however been considered by various governments/regimes as an avoidable drain on the country's foreign exchange earnings, in view of the abundant natural endowments for expanded production in Nigeria.

In the past, the growth recorded in domestic rice production was due mainly to area expansion. However, recent strategies through research system sought to increase production through intensification, based on the development and dissemination of improved rice varieties and other modern inputs as a composite package to rice farmers. Oyekanmi (2008) and Nwite,(2008), reported that from research stations (based on their on-station and on-farm trials), showed that the adoption of the technologies and improved management practices lead to substantial yield increases in rice production. This invariably underscores the significant role that technology stands to play in attaining the much needed growth in the rice sub sector.

DEVELOPMENT PARTNERSHIPS

Partnerships are of central importance to development practice in the 21st Century. The concept has become generally accepted as being fundamental for the success of poverty 'elimination'. It is used to refer to a wide range of different kind of relationship, often with insufficiently rigorous assessment being applied, either to its meaning or to its substance. Beneficial development practice should involve different groups of people and institutions (Mercer 2003; Slater and Bell, 2002). Two main ways in which the term 'partnership' is used in development practice are:

the relationship between donors and recipient governments (usually global partnerships); and tri-sector initiatives combining the private sector with government and civil society (often partnerships at a national or regional scale). In addition, the term

'partnership' is sometimes used to refer to activity focused projects that draw on the expertise of various stakeholders, invariably at a local or national scale. In some instances, all three usages coalesce but failing satisfactorily to distinguish between the interests behind each of these approacheswhich often leads to confusion and can also have damaging effects on the ability of poor people to enhance their lives (UNESCO, 2005).

AGRICULTURALTECHNOLOGY SYSTEM

Agricultural Technology System (ATS) is defined by Kaimowitz (1991) as consisting of all the individuals, groups, organisations and institutions engaged in developing and delivering new or existing technology. Ellis (1992) described ATS as a National Agricultural Research System (NARS) - this includes many organisations, public and private, that are involved in generating various forms of agricultural technology. Swanson (1988) described the following indicators in analysing ATS:

Public policy: This guides the direction of agricultural development by establishing a course of action and goals at national level. Priorities are set, resources allocated and rules are elaborated, which create the environment for technological progress. Under this are the following indicators: - government financial commitment to agriculture - Investment in research and extension - Availability and utilization of agricultural credit - Pricing policy - Farmers participation in technology system.

Technology development: The indicators under this section measure factors that affect the performance of the research subsystem.These are: - Access to external knowledge and technology - Human resources for agricultural research - Resource allocation to research salaries and programme - Resource allocation to commodity focussed research

Technology transfer: This provides information on various resources and activities with knowledge transfer from researchers to farmers through extensionists. This considers the following: - Access to and availability of internal technology - Personnel administration and supervision - Time allotted to technology transfer - Resource allocation between extension salaries and programmes - Technology dissemination - Personnel resources for extension.

Technology utilization: This is concerned with the primary objectives towards which the entire technology system has been aimed. It focuses on: - Availability of technology - Access to technology - Technology adoption. Kaimowitz and Merril-Sands (1989) explaining the institutional agricultural technology system, posited that links between research and technology transfer have both functional and institutional meaning. Thus, the links between them may be discussed from two points of view; they may be seen as functional links, which relate to the institution and personnel were identified to be influencing research technology transfer namely:

Political factors: consider the historical legacy, current political and social structure and external pressure in terms of national policy, foreign donor and private sectors.
Technical factors: measure the farmer's input and target; environmental diversity, communication channels and infrastructure, level of pre-existing knowledge about the environment, the dispersion and accessibility of the farming population.
Organisational factors: examine the interdependence between components and compatibility of management style, size consideration, different staff orientation and functional or market based organisations.

Agricultural Knowledge Information System (AKIS)
Rolings (1991) analyzed Agricultural Knowledge Information System (AKIS) and identified four basic processes in which all participants in an AKIS are engaged. These basic processes are:

Generation - This is often attributed only to research, yet public agricultural research is not more than 100 years old in most countries. Farmers have, however, managed to develop their agriculture for thousands of years. Knowledge generation appears to be more effective when carried out in-groups than when attempted individually.

Transformation - This is perhaps the most crucial processtaking place in the AKIS. The essence of an AKIS is that knowledge generated in one part of the system is turned into information for use in another part of the system. The following transformations take place from:

i) Information on local farming systems to research problem;
ii) Research findings to tentative solutions to problematic technologies;
iii) Research problems to research findings;
iv) Technologiesto prototype recommendations for testing in farmer's field.
v) Recommendation to observation of farmers' behaviour;

vi) Technical recommendation to information affecting service and behaviour;
vii) Adapted recommendations to information disseminating by extension and
viii) Extension information to farmer's knowledge.

Integration - This is carried out by all participants in an AKIS. The review articles produced by scientific disciplines to pull together research results are obvious examples. Leaders of multi-disciplinary research teams are engaged in a continuous effort to integrate research results produced by different disciplines.

Storage and retrieval - These processes would seem to be typically the taste of specialized libraries but most researchers, extension workers and farmers store and retrieve information. Rolings (1991) therefore stated that the analysis of AKIS must be examined against the backdrop of:

i) Policy environment which formulates the laws and incentives that influence agricultural performance;
ii) Structural conditions, such as market inputs, resource base, infrastructure and the structure of farming;
iii) Political and bureaucratic structures through which interest groups influence the system; and
iv) External sector, comprising of the donor agencies, international agricultural research centers (IARCs) and/or commercial farms. The analysis could cover the comparison of major components, linkage mechanisms, management decisions and actual and formal systems. Identifying institutional and functional gaps and investigating how actors see them as playing complementary roles.
Cycle of Partnership Formation

Various authors studying partnerships in development scenarios have made clear that partnership building occurs through several phases. Partnerships begin when a common interest arises and end when the proposed results are achieved or when the partners decide to terminate the partnership. Nevertheless, the process is interactive: some phases overlap, new problems and ways of operating the partnership arise and processes that were already completed must began again (Hartwich et al. 2007).

Phase 1: Identifying the Common Interest: The point of departure is usually a technical problem or a technological or market opportunity that can be resolved or addressed by research. The problem or opportunity may have already been identified by the public and private actors based on previous relationships or through a formal process of identifying a common interest. The common interest changes each time a new member enters the partnership or an old one departs. Therefore, it is often useful to develop a strategic vision that will allow the partnership to orient itself when it must adapt to changes in the socio-economic context (Bovaird, 2004).

Phase 2: Negotiating the Partnership Contract: In this phase, the potential partners begin to develop the partnership's activities and discuss the expected costs versus the possible benefits. The goals of the partnership are reviewed, as are the interests and capacities of the potential partners. The main subjects of negotiation at this phase are: financing, distribution of benefits and intellectual property, structure or organizational design of the partnership and specific partnership activities (Crawford, 2003).

.Phase 3: Operation: In this phase, the proposed activities of the partnership are put into practice. Some strategies that can improve the operation of partnerships include: confidence building, transparency, understanding different cultures and strategic vision (Hartwich et al 2007).

Phase 4: Monitoring and Evaluation: The evaluation of a partnership can have different purposes, such as justifying the use of funds, understanding whether the expected results have been or are being generated and how efficiently they are being realized and identifying the strengths and weaknesses of the partnership in areas related to administration, management, leadership and the synergetic effect produced (Bovaird, 2004).

Phase 5: Termination or Continuation: After evaluating the partnership and examining whether the expected results have been achieved, the partners must choose whether to continue or terminate the partnership (Hartwich et al, 2007).

METHODOLOGY

A qualitative approach was used in this study and participant's observation and in-depth interviews were conducted to collect data for the study. The study population involves the participating researchers and farmers in Nigeria and Ghana. A purposive sampling technique was used, due to the fact that the number of participating scientists is limited and that of farmers has been increasing every season. The checklist for the interviews was based on the list of 21 activities that were developed from literature on partnership and linkages in agricultural technology development. The ranking of the partnership activities were collated and presented in table formats

Table 1: Partnership activities among major stakeholders in Sawah rice technology development

Partnership activities	Japanese Institutions and researcher	Scientists in Ghana and Nigeria Institution	Farmers in Ghana and Nigeria
Joint problem identification	X X X	X X	X
Joint priority setting and planning	X X	X	X
Joint programming	X X X	X X	
Joint technology publication	X X X	X X X	
Collaborative professional activities	X X X	X X	X
Joint research contracts	X X X	X X	
Joint research activities	X X X	X X X	
Exchange of resources	X X X	X	X
Joint facilities	X	X X	X X
Joint financial resources	X X X	X	X
Staff rotation		X X X	X X
Dissemination of knowledge	X X X	X X X	X X X
Joint publication	X X X	X X X	
Joint reports	X X X	X X X	
Joint demonstration trials	X X X	X X X	X X X
Joint field days	X	X X X	X X X
Joint audio-visual materials	X	X X X	X
Joint seminar and workshop	X X X	X X	
Cross training	X X X	X X	X X
Evaluation survey	X X X	X X	X
Evaluation meeting	X X X	X X	X
Evaluation field visits	X X X	X X	
Evaluation reports	X X X	X X	

Scientists in Ghanaian and Nigerian Institutions were only prominent in 9 out of the 21 listed activities. These activities are joint technology publication, research activities, staff rotation, and dissemination of knowledge, publication, reports, demonstration trials, field days and audio-visual materials. The institutional mandate of the participating research scientists from Ghana and Nigeria may be responsible for this trend of involvement in the partnership development activities. The high participation of scientists in Ghanaian and Nigerian Institutions in partnership activities implies that, when development is the focus and mandate related, resources are likely to be utilized effectively in carrying out these functions.

Farmers in Ghana and Nigeria were only prominent in 3 out of the 21 development activities. These are dissemination of knowledge, joint demonstration trials and field days. The acquisition of knowledge associated with these activities could be responsible for their prominence. Their non-involvement in the other activities underscores the lack of complete or partial linkage existing between researchers, extension agents and farmers.While it is a known fact that majority of farmers are illiterate, it has been established that they are sources of vital information (local) that will enhance the development, acceptability and utilization of technologies.

The result showed that there is a significant difference in the involvement of Japanese institutions and researchers, scientists in Ghana and Nigeria and Farmers in these two African countries in the partnership activities in the sawah technology development process ($F = 16.87$, $p < 0.05$). The pattern of involvement as revealed by the mean involvement score, shows that Japanese institutions and researchers were more involved than scientists in Ghanaian and Nigerianinstitutions, which also participated more in the partnership activities in the sawah technology development process than Farmers from these countries. However the degree of involvement has enhanced the successful development and dissemination of sawah technology and there is need for the sustainability of the partnership activities.

Table 2: Analysis of variance comparing involvement in partnership activities by major stakeholders in sawah technology development

Partnership activities	Sum of Squares	df	Mean Square	F*	p	Kruskal Wallis Test **	df	p
Between Groups	18.087	2	9.043	16.87	.000	22.846	2	0.00
Within Groups	35.391	66	.536					
Total	53.478	68						

when scores were at interval level of measurement, ** when scores were ranked

CONCLUSION

The result has shown clearly that partnership activities were critical in the development and dissemination of the sawah technology in West Africa. It has also highlighted the varying degrees of involvement in partnership activities by the three major stakeholders in the technology development process. The varying degree of involvement in the partnership activities enhanced the successful development and dissemination of sawah technology and there is need for the sustainability of the partnership activities.

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PESTS AND DISEASES AS FACTORS AFFECTING RICE PRODUCERS COMPETITIVE ADVANTAGE IN SUB-SAHARAN AFRICA

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ABSTRACT

Rice production is affected by many constraints in the production system in Africa, mainly environment, biotic, management and socio-economic. Among these, insects and diseases are most important, both in Africa and Asia. Most insects causing damage to rice in Africa are indigenous species, while the severity of the insect pests differs with climatic zone and ecosystem. In Africa, insect pests are classified according to the parts of the plants they damage, i.e. internal stem feeders, root suckers, leaf feeders, stem and leaf suckers, ear cutters and grain suckers. Although there are about 70 known major and minor diseases of rice, Africa has about 11 but which may be very significant in yield losses. Severity of disease varies with climatic zone, ecosystem and causal agent. In some cases, more than one organism is associated with the disease, e.g. rice grain discoloration, where Sarocladium attenuatum (46.76%) isolation frequency, Fusarium (moniliforme) verticilloides (17.25%), Curvularia lunata (14.64%), Fusarium semitectum (14.25%), Pyricularia oryzae (4.75%), Nigrospra oryzae (15.33%) but non pathogenic andHelminthosporium oryzae (1.0%) have been found. Generally the dwarf, high yielding cultivars are more susceptible to most pathogens than the taller ones. The use of resistant varieties, judicious use of N-fertilizers, appropriate choice of planting time and crop rotation, quarantine and biological control are highly recommended for control of these pests and diseases in Africa.

INTRODUCTION

Rice is a strategic component of food security and a crucial element in the staple food economies of several African countries. Demand for rice in Sub-Saharan Africa is becoming more acute because of dietary shifts from traditional foods and this demand will likely continue to rise.

RICE ECOLOGIES

These are considerably varied (Table 1). About 50% of the area is upland (generally unfavourably), while the other 50% is subject to varied water regimes and nutrient imbalances. Only 11% of the entire area is irrigated.

PRODUCTION IN AFRICA

This has been drawing the attention of national and international agricultural policy makers recently. Africa has about 3.5% of the world's total rice area and nearly 2.2% of the total production. Per hectare yields in major rice growing countries in tropical Africa have generally been low since 1969. Rice production in Africa must be increased to avert a serious economic drain of foreign exchange reserve in most countries.

CONSTRAINTS

Rice production in Africa is affected by a wide range of constraints in the production system, especially environmental, biotic, management, and socioeconomic (Figs. 1 and 2, Tables 2-6). Among these, insects (Tables 2-4) and diseases (Tables 5-6) are the major constraints limiting rice production in both Africa and Asia. Cramer (1967) estimated the world's average yield loss at about 1/3 of the value of the crop, 13.8% (insects), 11.6% (diseases) and 9.5% (weeds). Barr, Koechler&Smith (1975) estimated the yield loss due to insects, diseases and weeds in Africa to be 33.7% of potential production, out of which insects and diseases account for 14.4% and 5.8%, respectively.

WAY FORWARD

Attention should be drawn to pests and diseases, as significant factors affecting rice producer's competitiveness. These factors should therefore be taken serious when formulating policies and strategies for promoting rice production and food security in Sub-Saharan Africa. Studies on the biology of these pests and pathogens of rice in tropical Africa will be one of the keys to the solutions.

CONTROL MEASURES

The use of resistant rice varieties, judicious use of N-fertilizers, appropriate choice of planting time and crop rotation, quarantine and biological control (biopesticide) are highly recommended.

RICE PLANT PEST **AFRICA** **ASIA**

Grain suckersStenocons spp. Leptocorisa acuta Aspavia spp.
Ear cutter Mythimna spp.
Stem and leaf suckers Nilaparvata meander[a] Nilaparvata lugens
Nephotettix spp.[a] Nephotettix spp.
Sagatodes cubarus[a] Sagatella furcifera
White flies Brevennin cebi
Mites Thrips

Leaf feeders Epilachna simile Dicladispa armigera Nymphula
stagnalis Cnaphalocrosis medinalis
Hispids Hydrellia spp.

Hydrelliaspp. Nymphula depunctalis
Spodoptera sp. Spodoptera mauritia

Internal stem feeders Chilo spp. Tryporyza incertulas
Maliarpha separatella Chilo spp.
Sesamia spp. Sesamia inferens
Diopsis spp. Orseolia oryzae
Orseolia oryzivora

Root feeders Termites Mole cricket
Mole cricket Termites
Root aphid

[a] Potential pests

Fig.1. Rice insect pests of major importance in Africa and Asia.
(Modified from: Alam et al., 1984).

RICE PLANT	*AFRICA*	*ASIA*
Grain Suckers	Stenocons Spp.	Leptocorisa Acuta
	Aspavia Spp.	
Ear Cutter		Mythimna Spp.
Stem and Leaf Suckers	Nilaparvata meander	Nilaparvata lugens
	Nephotettix spp.	Nephottix spp.
	Sagatodes cubarus	Sagatella furcifera
	White flies	Brevennin cebi
	Mites	Thrips
Leaf feeders	Epilachna simile	Dicladispa armigera
	Nymphula stagnalis	Cnaphalocrosis
medinalis		
	Hispids	Hydrellia spp.
	Hydrellia spp.	Nymphula
depunctalis		
	Spodoptera Sp.	Spododptera mauritia
Internal Stem feeders	Chilo spp.	Trporyza incertulas
	Maliarpha separatella	Chilo spp.
	Sesamia spp.	Seasamia inferens
	Diopsis spp.	Orseolia oryzae
	Orseolia oryzivora	
Root feeders	Termites	Mole Cricket
	Mole Criket	Termites
	Root Aphid	

***Potential pests**

Fig.1 Rice insect pests of major importance in Africa and Asia (Modified from: Alam et al., 1984).

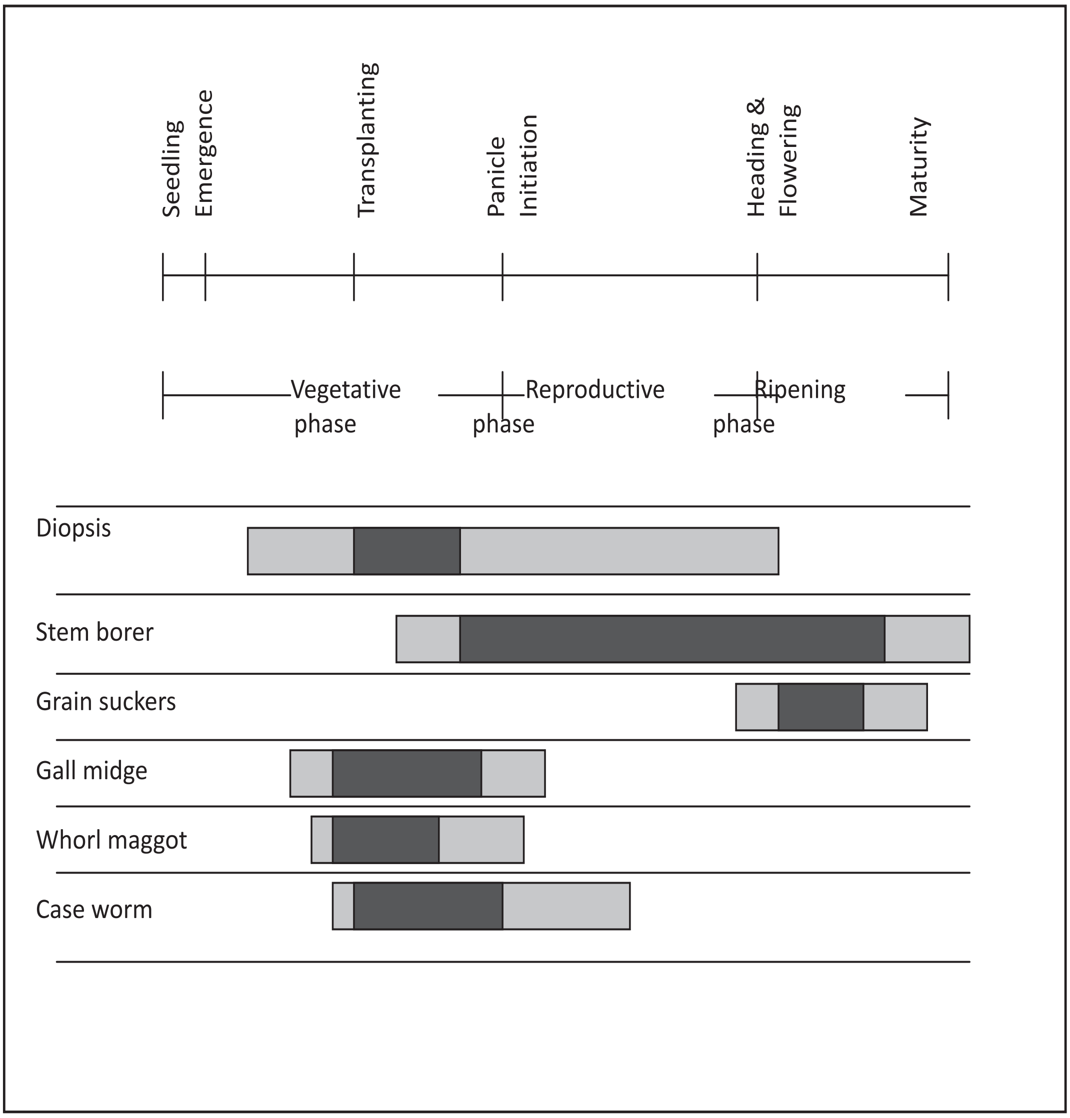

Fig. 2: Major insect pests of lowland rice in Nigeria and their relation to growth stage of plant (Updated from: Alam *et al*., 1984).

Table 1: Rice ecologies in sub-saharan Africa

East and Central

Ecology	**West Africa** Area in 1000ha	% of total	**Southern Africa** Area in 1000ha	% of total	**Total Africa** Area in 1000cha	% of total	
Upland	1437	62.5	610	33.7		20.47	49.8
Lowland	564	24.0	850	47.0		1414	32
Rainfed:							
(a) Hydromorphic	58	2.5	-	-	-	-	
(b) Inland swamps	506	22.0	-	-	-	-	
(c)Mangrove swamp	184	8.0	-	-	184	4.5	
Irrigated	115	5.0	350	19.3	465	11.3	
	2300	100.0	1810	100.0	4110	100.0	

Sources: Kuang (1984) ; Seshu (1986).

Table 2: Prevalence of rice pests in the major climate zones in Africa

Humid **Insect**	**tropical**	**savanna**	**savanna**
Maliarpha separatella	++	++	+
Chilo spp.	++	++	++
Sesamia spp.	++	+	+
Diopsis spp.	++	++	+
Orseolia oryzivora	-	++	++
Grain suckers	++	++	+
White fly	+	++	++
Termites	++	++	+
Army worm	+	+	+
Nymphula depunctalis	++	++	-
Whorl maggot	+	+	-
Black beetle	+	+	-
Aphid	-	+	-
Mole Cricket	-	+	+
Hispa	+	+	-
Leaf folder	+	+	-

Updated from: Alam *et al*. (1984).
++ = Abundant
+ = Present but not abundant
- = Absent

Table 3: Relative occurrence of insect pests in different ecosystems in Africa

Insect	Upland	Lowland	Irrigated
Maliarpha separatella	++	+++	+++
Chilo spp.	++	++	++
Sesamia spp.	++	+	+
Diopsis spp.	+	++	+++
Orseolia oryzivora	-	++	++
Nymphula stagnalis	-	+	++
Grain suckers	++	+	++
Termite s	++	+	-
Epilachna similes	++	+	+
Army worm	++	+	+
Aphid	+	-	-
Mole cricket	++	+	+
Whorl maggot	-	++	++
White fly	-	+	+
Black beetle	+	+	-
Leaf folder	+	+	+
Hispa	+	++	+

Updated from: Alam *et al*. 1984
+++ = Widely abundant
++ = Abundant
+ = Present but not abundant
- = Absent.

Table 4: Major insect pests of rice for which varietal resistance has been recorded

Common name	Scientific name	Varietal Resistance
Yellow stem borer	*Scripophaga incertulas*	A, B
Striped borer	*Chilo supperessalis*	A, B
	Chilo zacconius	A
Pink borer	*Sesamia* spp.	A
White stem borer	*Maliarpha separatella*	A
Stalk-eyed fly	*Diopsis macrophthalma*	A
Gall midge	*Orseolia spp.*	A, B, C, D
Brown planthopper	*Nilaparvata lugens*	A, B, C, D
Green leafhopper	*Nephotettix virescens*	A, B, C
White backed planthopper	*Sogatella furcifera*	A, B, C
Rice whorl maggot	*Hydrellia philippina*	A, B
Rice delphacid	*Sogatodes orizicola*	A, B
Rice bug	*Leptocorisa varicornis*	A, C
Rice stink bug	*Oebalus pugnax*	A
Rice leaf folder	*Cnaphalocrosis medinalis*	A
Rice hispa	*Dicladispa armigera*	A
Rice thrips	*Baliothrips biformis*	A
Zigzag rice leaf hopper	*Recilia dorsalis*	A
Rice case worm	*Nymphula stagnalis*	A

Source: Alam*et al*(1984).

A = Source of resistance identified
B = Resistant varieties released
C = Genes for resistance identified
D = Insect biotypes encountered.

Table 5: Common diseases of rice in Africa, parts of plant affected and causal organism(s) reported.

Disease	Part of plant affected	Causal organism(s)
Blast	Leaf, node, flowering axis	*Pyricularia oryzae* Cav.
Leaf scald	Mature leaves (tips)	*Rhynchosporium oryzae* Has. *(Monographella albescens)*
Sheath blight	Leaf sheaths, leaves	*Rhizoctonia solani* Kuhn (*Thanatephorus cucumeris* (FR)
Sheath rot	Upper most leaf sheath	*Sarocladium oryzae* (Sawaba) Gams & Hawks.
Narrow brown leaf spot	Leaves, sheath	*Cercospora oryzae* Miyake.
Brown spot	Leaves, spikelets	*Helminthosporium oryzae* Breda de Haan (*Cochliobolus miyabeanus* Drech ex Dastur)
Grain (glume) discoloration	Grain (spikelet)	*Sarocladium attenuatum* (Sawada) Gams & Hawks *Fusarium moniliforme* *Curvularia lunata* *Fusarium semitectum* *Pyricularia oryzae* *Helminthosporium oryzae*
False smut	Spikelets, Grains	*Ustilaginoidea virens* (CK) Tak.
Bacterial blight	Leaves, basal stem, root	*Xanthomonas campestris* pv. *oryzae*
Bacterial streak	Leaf blades	*Xanthomonas compestris* pv. *oryzae translucens*/ f. sp. *oryzicola*
Rice yellow mottle virus[a]	Whole plant	Rice yellow mottle virus

Sources: Swaminathan (1985) ; Ngala (1982, 1983, 1986, 1987) ; Alam. (1984).

[a] African specific.

Table 6: Resistant varieties for rice diseases.

Disease	Resistant donor	
	Tall	**Dwarf**
Blast	Tetep	ITA 257
	Lac 23	ITA 120
	OS 6	ITA 150
	Moroberekan	IRAT 13
		IRAT 14
Leaf Scald [a]	Remadja	-
Sheath blight [a]	Ta-poo-cho-z	Pankaj
	Dissi Hatif	-
Bacterial blight [a]	BJ1	IET 4141
	DV 85	
	Cempo Selak	
Rice yellow mottle	LAC 23	
	Moroberekan	IR 1846-293-3
	OS 6	

[a] **Results from tests outside Africa.**
Source: Alam *et al* (1984)

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LEARNING ALLIANCES IN SAWAH RICE TECHNOLOGY DEVELOPMENT AND DISSEMINATION IN NIGERIA AND GHANA

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ABSTRACT

Millions of dollars are spent each year on research and development initiative on rice in order to improve the livelihood of farmers and other stakeholders in the rice value chain, however little has been the impact. Major reasons for this failure include the limited collective learning that occurs between various stakeholders and the neglect of building a multi-stakeholder innovation systems for rice in West Africa. This has made research results less relevant and the impact on farmers worse off. This paper describes how Sawah rice production technology has evolved through learning alliances that involves social learning and innovation systems and brings Japanese institutions, research institutes, Ministry of Agriculture, extension agencies, farmers groups, Millennium Village, marketers, and universities in Nigeria and Ghana together on a platform with clear objectives, shared responsibilities, cost and benefits, output as inputs, differentiated learning mechanisms, long term and trust-based relationships. The process is increasingly leading to increased learning and effectiveness in rural entrepreneurial development and improved livelihoods. The paper gives a description of the scenarios, based on experience in the Sawah rice technology development and concludes with its application in other parts of West African sub-region.

INTRODUCTION

Cereal production per capita has been stagnant for more than thirty years in sub-saharan Africa, while in Asia it has grown about 1.5 times (FAO, 2006). This contrast is explained by the fact that "Green Revolution" has not taken place in sub-saharan Africa. Although cereal yields in sub-saharan Africa have been increasing during this period, their growth rates are much lower than those achieved in Asia (FAO, 2006). Naturally, this raises a concern about future food security in sub-saharan Africa. Not only this stagnation in general, if the performance of each crop is looked at,has gap that exist between regional supply and demand for riceto widen because of a shift in diet away from traditional coarse grains due to by urbanization (WARDA, 2008). As a result, rice imports in West Africa attained 2.8 million tonnes in 1998 and are projected to be between 6.5 and 10.1 million tonnes in 2020 (Lançon and Erenstein, 2002). It is well known that while the Green Revolution of rice in Asia was led by the release of modern varieties, irrigation and chemical fertilizer are necessary condition to achieve their potential high yield. In West Africa also, varietal improvement of rice has a significant impact on the regional economy (Dalton and Guei 2003).

The dominant paradigms of research have been associated with the frameworks that are concerned with the supply and demand of agricultural innovation in developing countries. According to Oladele (1999), these are Transfer of Technology (TOT) which was the main approach of agricultural research in the 1950s, in which the generation and diffusion of innovation is a linear process, from rich-country research institutes to poor-country research stations and from them to extension officers and to farmers. The Adaptive Technology Transfer (ATT)model recognised the location-specific requirement of technology and farmer behaviour is no longer seriously regarded as a barrier to adoption. The focus is to adapt new technology to local conditions and to remove the socio-economic constraints to adoption by farmers, such as the availability of complementary inputs of credit. This model was prevalent in the 1970s and early 1980s. In this model, the generation and diffusion of innovation remains a predominantly linear process, with limited feedback from the farmers. Farming Systems Research (FSR)emerged in the mid-1970s and became prevalent in the 1980s to ensure the reach of innovations to resource-poor farmers. FSR greatly changed the status of the farm household and the farm system in the generation and diffusion of new technology. This, it did, by placing emphasis on discovering from farmers, their goals and constraints. Farmer-First Research (FFR) came out of the argument against the FSR solution to the matching of research priorities with farmer's needs, did not go far enough in drawing on the knowledge and experimental skills of farmers. The expert staff of the research station - scientists, social scientists and their assistants remain firmly in control of the data elicited from farmers, the design of on-farm trials and the nature of the technology eventually recommended for wide spread adoption.

The multiple sources of innovation model (Biggs, 1985; Biggs and Clay, 1981) proposes that ideas and genetic resources for new technology spring from multiple sources, not just from a narrow sequence of basic and applied research carried out by scientists within the formal research system. The model is complementary to the farmer-first model. It emphasizes the non-linearity of the process by which new farm technology is generated and the many different sources in space and time of genetic materials and farming methods. Chambers and Ghildyal (1985) proposed the Farmer-First-and-Last,which states that for technologies to better satisfy the needs and conditions of resource-poor farmers, there should be a systematic process of scientist learning from and understanding of their resources, needs and problems. Scoones and Thompson (1994) introduced Beyond Farmer-First,which points to where the farmer-first approach lacks certain analytical depth and presents a more radical programme that incorporate socio-politically differentiated views of development. The model highlights gender, ethnicity, class, age and religion having important implications for research and extension practice. It emphasizes that different types of local and non-local people hold many divergent, sometimes conflicting interests and goals, as well as differential access to vital resources. Knowledge, which is diffuse and fragmentary, emerges as a product of the discontinuous and inequitable interactions between the actors, i.e. researchers, extensionists and farmers (IIED, 1994). The need for translating research findings into effective development outcomes that improve the livelihoods of the rural poor on a broad scale, are often expressed regarding international agricultural research and research institutes in particular, given their mandates for food security, improved livelihoods, and sustainable resource management.

Learning Alliances are a series of connected stakeholder platforms, created at key institutional levels (typically national, intermediate and local/community) and designed to break down barriers to both horizontal and vertical information sharing and thus to speed up the process of identification, development and uptake of innovation. Each platform is intended to group together a range of partners with complementary capabilities in such areas as implementation, regulation, policy and legislation, research and learning and documentation and dissemination.

The central premise of the Learning Alliance approach is that, by giving as much attention to the processes of innovating and scaling up innovation as is normally given to the subject of the innovation itself, barriers to uptake and replication can be overcome. The Learning Alliance approach has arisen from a sense of frustration over the evident failure of much relevant and effective innovation – technological or institutional – to move beyond the pilot stage (International Water and Sanitation Centre, 2005).

At its simplest, a "Learning Alliances" is a series of linked platforms, existing at different institutional levels (national, district, community) and created with the aim of bringing together a range of stakeholders interested in innovation and the creation of new knowledge in an area of common interest. The stakeholders involved should have complementary capabilities which, when combined, will allow the new knowledge created in the innovation process to be brought to scale. Some of the key capabilities required are in: implementation, regulation, policy and legislation, research and learning, and documentation and dissemination. Learning alliances require facilitation to overcome barriers to interaction and communication within and between the stakeholder platforms. They aim to enable a shared learning process in which barriers to horizontal and vertical information sharing are broken down. Learning alliances, by involving key stakeholders at all levels in the process of knowledge creation, aim to ensure that innovation takes place within a framework of local and national conditions and norms that ensure that what is produced is relevant and appropriate (James, 2001).

The concept of Learning Alliances is built around the central proposition that only an integrated approach to the process of innovation, bringing together all stakeholders (practitioners, researchers, policy makers, activists), can address the range of failings earlier described. At the same time the processes of interaction within the Learning Alliance should foster a sense of ownership of the founding concepts and approaches, ensuring that the innovation developed is appropriate to the local situation and capable of replication with existing (or realistically achievable) resources, institutions and policies.

LEARNING ALLIANCES AND OTHER RELEVANT CONCEPTS

This section examines the relationship with some key concepts, which preceded Learning Alliances and on which the latter are built. According to Ruaysoongnern and Penning de Vries (2005) these include, action research, communities of practice, stakeholder platforms and participatory research and learning in the agricultural sector.

Action research- uses approaches designed to solve practical problems in support of and with the active collaboration of stakeholders. It is a flexible process which allows action and multidisciplinary research to be achieved at the same time (Dick, 2002). It is a win-win format: the action is more efficient and the research more relevant. A critical concept of action research is cycles of active experimentation, followed by reflection. This cyclical approach is fundamental to any system that wants to create adaptive, flexible and context-specific knowledge. It is therefore of key importance in Learning Alliances.

Capacity building - Traditional approaches to capacity building often confuse it with training. While training and education are of course enablers of increased capacity, it is vital that people are, at the same time, given the opportunity to put their new knowledge into practice. Learning Alliances provide a structured framework for doing so, by integrating the capacity building process into the ongoing planning and implementation activities of sector organisations and communities. In this way capacity building is also reinforced by the action/reflection cycles of the action research approach.

Multi Stakeholder platforms - There are several definitions and types of Multi Stakeholder Platform (MSP) but in essence, an MSP is a "negotiation and/or decision-making body (voluntary or statutory), comprising different stakeholders who perceive the same resource management problem and realize their interdependence (Warner, and Verhallen 2004)

STAKEHOLDER IDENTIFICATION, ROLES AND RESPONSIBILITIES WITH LAs

Learning alliances begins with a core or founding group of actors whose interest in innovation is to be served by the creation of a learning alliance. It is crucial that this core group has a clear idea of what they want to achieve and how they intend to do it. Only in this way will they be able to attract the interest of other key stakeholders.

The core group will get bigger as the work of the alliance increases and more stakeholders buy into the idea.

Stakeholders' involvements depend on such factors as the specific work topic, the organisations available and interested, and the resources available. What is important is that stakeholders have a shared vision of the objectives of the alliance and background skills that can contribute to achieving them. Which stakeholders should be involved at the different levels (and different stages) is something to be worked out organically by the founding members, as they seek to develop a coalition around their area of interest and innovation. Ideally, each participating organisation should have some existing level of interest in innovation related to a specific area. An important exception is actors without such a direct interest who, because of their position, could impede or block progress at a later stage. They should be drawn in to the Alliance to avoid or reduce that possibility. Fig. 1 shows the structure of learning alliances at different levels of operations.

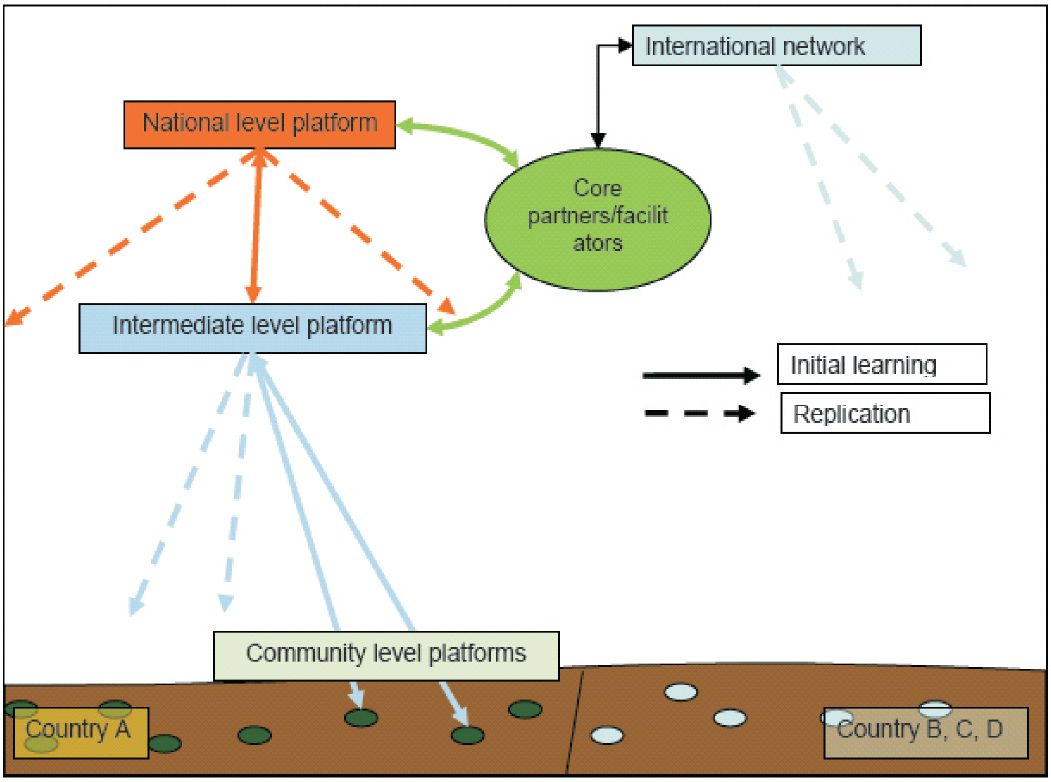


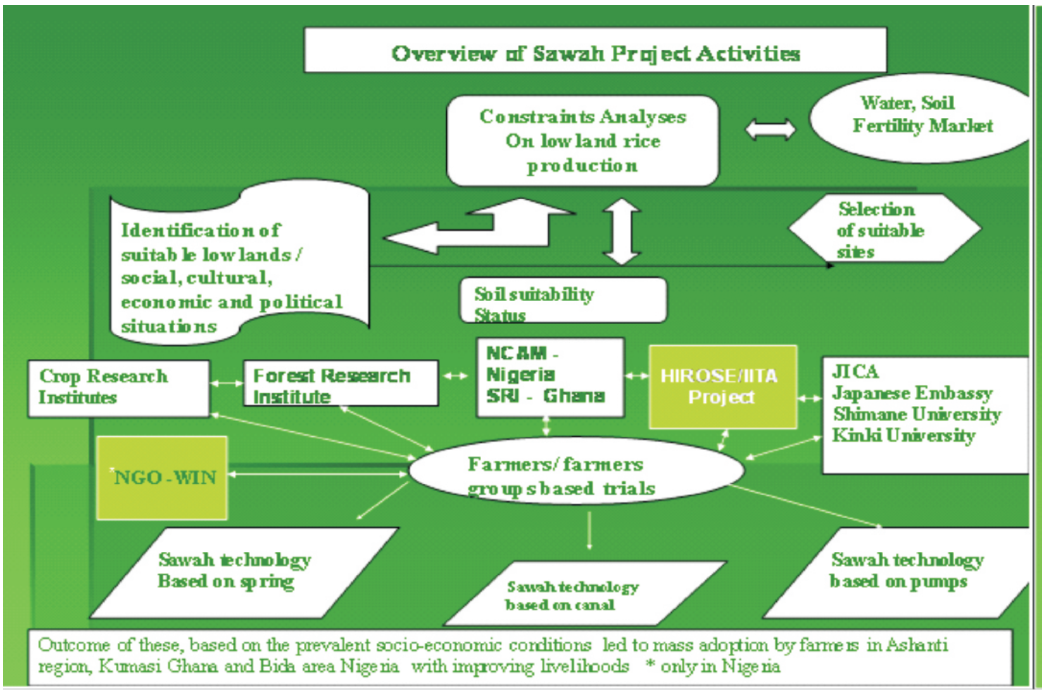
Figure 1: Structure of Learning Alliances at different levels

INTRODUCTION OF SAWAH RICE PRODUCTION TECHNOLOGY IN NIGERIA AND GHANA

Sawah rice production technology refers to improved man-made rice-growing environment, through eco-technology, with leveled rice field surrounded by bund with inlet and outlet connecting irrigation and drainage. Fig .1 shows the pattern of sawah in the inland valleys in Nigeria and Ghana. Sawah fields are the systems adaptable to a lowland ecosystem but require eco-technological skills, including those for minimum changing of topographical and ecological features, such as land leveling, bunding and irrigation/drainage systems. Wakatsuki & Masunaga (2005) reported that the potential of Sawah based rice farming is enormous in West Africa in order to stimulate the long awaited green revolution. This is predicated on the fact that the agro-ecological conditions of the core region of West Africa are quite similar to those of northeastern Thailand, which is one of the rice centers in that country.

In Nigeria, Sawah based rice production started after preliminary basic research work on the suitability of inland valleys by Japanese researchers. A 1.5 ha field at Ejeti village was cultivated in 2001. In 2002, three farmers participated in Sawah Package program and farmers increased to 14 and 18 in 2003 and 2004, respectively. In 2010, farmers have increased to 1500. Similarly, there has been tremendous increase in the yield of farmers adopting sawah package on their rice farms. The 3 phases of the sawah development process in Ghana from 1997 till date are: Integrated Watershed Management of Inland Valleys by JICA - CRI (1997-2001);Sawah project by SRI - Shimane Univ., Kinki University Japan (2002 -2004) andInland Valley Rice Development Project by MOFA – ADB (2004 -2009), with the goal of sustainable rice production (Nakashima et al 2007). The average rice yield obtained from Sawah plots of between 4.5 to 5.2 t/ha is enhancing the transformation of the potential for rice production being transformed into actual production in Nigeria and Ghana.

Fig. 2 presents the overview of the alliances in the Sawah technology development process. From the figure, the international networks that exist are shown in form of relationships between Japanese and research institutes in West Africa. It also highlights the platform levels in the vertical and horizontal levels for alliances to be effective.



EMPOWERMENT THROUGH LEARNING ALLIANCES

The involvement of farmers' organizations in the technology development process enhances the empowerment process for the technology in terms of human capital (such as skills), social capital (including farmer organizations and laws), economic capital (loans, revolving funds, remittances), physical capital (farm and village infrastructure, internet) and natural capital (land, water, genetic resources). The livelihood approach to rural development recognizes that five capitals are required for development.

The Learning Alliances at the individual level (promoting human capital) enhances self analysis for self actualization, happiness oriented, cash as an only supporting factor, self reliance system and autonomy, skill building and knowledge and life security through improved production and family system. At the household level (promoting human and natural capital), farmers were able to gain skills and knowledge, autonomy, food quality and security, economic sufficiency, land and water resource security, biodiversity, local wisdom utilization and family livelihood and self sufficiency. At the community level (promoting human and social capital), the Sawah technology learning alliances enhances skill building and knowledge sharing, caring and sharing society, community business, social security, cultural protection and environmental quality. It has also contributed At the group and network level (promoting human, social, financial and natural

capital) for skill building, experimentation and knowledge sharing, learning organization, education for life at all levels, creation of a revolving fund, caring and sharing, local wisdom and cultural conservation, sustainable development and policy integration (Polaket al, 2004)

LEARNING ALLIANCES AS A VEHICLE FOR SCALING OUT

LAs is a process undertaken jointly by R&D agencies through which research outputs are shared, adapted, used and innovated upon. This is done to strengthen local capacities, improve research outputs, generate and document development outcomes and identify future research needs and potential areas of collaboration. The LAs process begins with the identification of research outputs or development outcomes susceptible to scaling out by partners. It is followed by one or many adaptation and learning cycles and is completed with the detection of new research demands, which feed back into the research process and contribute to the generation of improved livelihood or policy outcomes. Fig. 3 shows the LAs process.

According to Douthwaite et al (2002), several key issues need to be managed for LAs to be successful and include Clear objectives- Clear objectives based on the needs, capacities and interests of the participating organizations and individuals must be

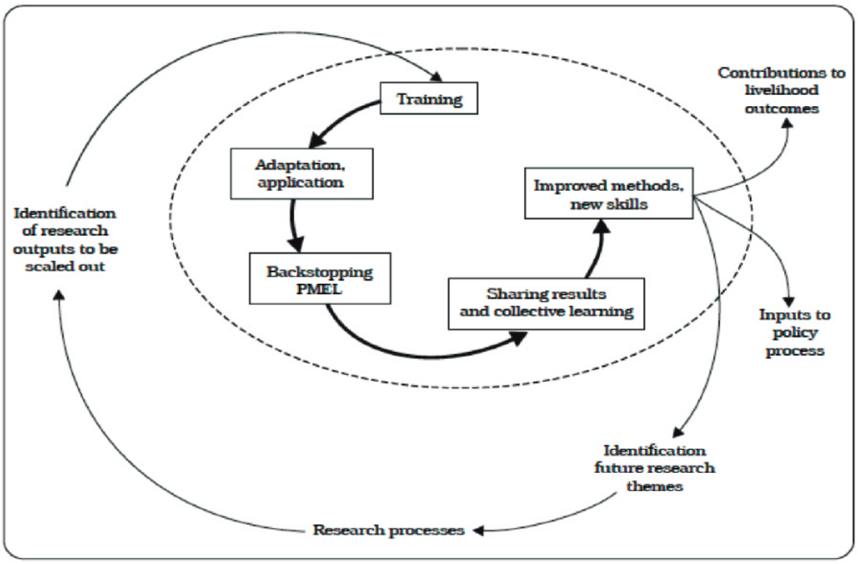


Figure 1. The Learning Alliance process (PMEL = participatory monitoring, evaluation, and learning).

defined. In the case of Sawah technology, the need to increase rice yield, sustain increased yield, production of quality rice and demand-driven research were the objectives. Shared responsibilities and costs - In the learning alliance for sawah technology development and dissemination LA seeks to benefit all parties; therefore responsibilities and costs should be shared. Responsibility and costs are shared, although it was skewed in the begining towards the Japanese institutions as donors of the project.

As time progress and to ensure that sustainability efforts are in place to spread more of the costs and responsibilities. Outputs as inputs- In order to enhance the overall process of development and livelihoods of the farmers through sawah technology, several outcomes of trials and experimentations and discussion are used as inputs into refining the process and scaling out of the technology. Differentiated learning mechanisms -Learning Alliances have diverse groups of participants, ranging from farmers, women, scientists, extension agents and ministry staff, NGOs and international scientists. Identification of each group's questions and its willingness to participate in diverse aspects of learning processes was the key issues of alliance. Long-term relationships- The sawah technology development process has stretched over many years, as far back as 1986 when preliminary survey and soil analysis started with relationships with farmers, research institutes and international scientists. These relationships should orient researchers' agendas towards key issues that contribute to positive change and on the other hand, inform development practitioners of new or improved methods or tools that improve their practice. The transaction costs involved in establishing and maintaining LAs and their long-term nature indicate that quality should take precedence over quantity (Solomon, and Chowdhury, 2002).

Conclusion

This paper shows how Sawah rice production technology has evolved through learning alliances that involves social learning and innovation systems and brings Japanese institutions, research institutes, Ministry of Agriculture, extension agencies, farmers groups, Millennium Village, marketers and universities in Nigeria and Ghana together on a platform with clear objectives, shared responsibilities, cost and benefits, output as inputs, differentiated learning mechanisms, long term and trust-based relationships. The process is increasingly leading to increased learning and effectiveness in rural entrepreneurial development and improved livelihoods. The paper gives a description of the scenarios based on experience in the sawah rice technology development and concludes with its application in other parts of West African region.

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Farmers' personal irrigated sawah systems to realize the green revolution and Africa's rice potential

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ABSTRACT

Among the 250 million ha of lowlands in Sub Saharan Africa (SSA), only about 10% (20 million ha) are estimated as appropriate sites for sustainable irrigated sawah system development, because of hydrological, topographical and pedological limitations. Of all lowland types, inland valley is the priority, because of relatively easy water control. Both large-scale and small-scale irrigation projects, typically Official Development Assistance (ODA), have been very costly because of major dependency on heavy engineering works by outside expertise. Due to the high construction costs, the economic returns remain negligible or negative for a long period of time (20-30 years). Project ownership remains with the government (engineers) rather than with the farmers. Therefore, neither the development nor the management is sustainable.

The site specific farmers' personal irrigated sawah system development offers low cost irrigation and water control for rice intensification, with sustainable paddy yield of 4-6 t/ha. If we apply improved agronomic practices, such as System Rice Intensification (SRI), based on the sawah systems, paddy yield can be higher than 10t/ha. However, African lowlands are quite diverse and different from Asian lowlands. Therefore careful site-specific sawah development and management technologies have to be researched, developed and disseminated. To develop and manage sawah systems by local farmers, self-propelled efforts and small-scale equipment, such as hydropower tillers are needed. After many trial nad error processes, the sawah system has been successfully tested from 1997 to 2009 in Ghana and Nigeria, especially in locations where appropriate sites were selected and trained local leading farmers backstopped properly.

INTRODUCTION

This presentation will discuss five important skills and technologies in details: (1) site selection and site specific sawah system design, (2) skills for cost effective sawah systems development using hydro-powertiler, (3) farmers organization for successful on-the-job training, development and management of sawah systems, (4) sawah-based rice farming to realize at least the sustainable paddy yield > 4t/ha and (5) establishment of institutional training and dissemination systems for sawah ecotechnology. Since rice farmers have to master relatively wider range of skills including ecological engineering, intensive on-the-job training is very important. Once mastered, the skills can be transferred from farmer-to-farmer to scale up the success as was done in Ashanti in Ghana and Bida, Abakalilki, Akure, Zaria, Adani and Ilorin in Nigeria to wider areas in SSA to realize Africa's rice green revolution.

General time schedule for sawah approach to establish a model sawah system of 2-3 ha

I. Site selection: 2-3days per potential site

(1) The priority site is an ongoing major area of Fadama rice cultivation: The best season for the site selection will be September/October, just before harvesting, to January/February, just after harvest. Intensive hearing from rice farmers on the local hydrological conditions for the past 10-15 years is important.

(2) Secured continuous water flow: >5months, base water discharge: >201/sec, i.e., >1500-2000m^3/day, potential irrigated sawah area:>10-20 ha,

(3) No strong flood attack: Flood depth will be <50cm and continuation of the flood will be <3-4days, flood water discharge will be <10 ton/sec

(4) Flat and very gentle slope:<2%, if slope is <0-1%, leveling operation is easy.

(5) Strong will of rice farmers to master sawah technology skills and sawah development by farmers' self support efforts.

(6) Good road access for demonstration

II. NEW SAWAH DEVELOPMENT FOR DEMONSTRATION: TWO TO THREE MONTHS

Three to four extension officers from sate Agricultural Development Project ADP) or Fadama III offices and 3-10 active farmers will be trained through intensive OJT by one or two sawah specialists (IITA's Hirose Project, NCAM sawah team,UNN and Abeokuta sawah teams in Nigeria).

(1) Bush clearing, de-stumping and delineation of possible sawah area: : 10-20 work-days/ha

(2) Site survey and mapping: 1-3 work-days/ha
Put in 1-3 of about 100m X and Y axis lines using survey tools, such as Total Station (Cannon Co. Ltd.) if possible. If not available, use 90^0 crossed lines using simple measuring tools, then draw upland and lowland border and river/canal line, land owner/tenure lines

(3) Sawah delineation based on contour line with 30cm height difference: 5 work-days

(a) Should be started from the lowest valley bottom at each land owner/tenure lines,

(b) Should be straight line and large size as possible for efficient use of power tiller,
(c) use pegs and white rope to delineate bunding, border of land, existing canal lines

(4) Bunding: 15-25 work-days/ha
standard size is 50 cm x 50 cm ±20 cm
A: Big bund: Flood prone area, land tenure line
B: Standard: major sawah delineation
C: small bund: sub-sawah delineation

(5) Canal and drainage lines: 10-60 work-days/ha

(6) Dyke: 30-50 work-days/ha

(7) Nursery preparation: 3 work-days/ha in three phases, about three weeks intervals, one day for each phase: nursery must prepare 15 to 25 days before transplanting

(8) Sawah ploughing, puddling, leveling and smoothening: 50-80 work-days/ha

III. Sawah based rice farming in the first year of new sawah development

(1) Sawah water control: 10-40 work-days/ha

(2) Sawah systems maintenance: 10-30 work-days/ha

(3) Transplanting: 10-20 work-days/ha

(4) Fertilization: 2-3 work-days/ha

(5) Weeding: 6-7 work-days/ha

(6) Bird-scaring: 10-30 work-days/ha

(7) Harvest: 7-15 work-days/ha

(8) Threshing: 10 work-days/ha

The most important factor in site selection, appropriate sawah system design, development and management is collaboration between researchers and farmers. Scientists and extension officers should have the skills for sawah development. Although local farmers do not know sawah technologies (before the project starts), they are very familiar with the site-specific hydrological conditions that scientists and extension officers need to know for sawah development. Thus, collaborative action-research between farmers and scientists is essential. The priority for site selection is inland valleys. Flood-plains will be a lower priority at the beginning of the application of the sawah approach. The water conditions of inland valley streams are critical. Water has to flow for more than 5 months continuously, with a discharge of more than 10 1/s. Otherwise, farmers have to develop additional ponds and tanks to secure water for sustainable sawah-based rice cultivation. If floods reach deeper than 50 cm and continue longer than 1 week and/or the discharge of more than 10 m^3/s, major flood control measures have to be put in place. This is difficult for farmers' group at the extra first stage of sawah development. Therefore, inland valleys that will require such extra inputs should be avoided in the demonstration and training stage.

(1) Site Selection and *Sawah* system design **(2) Development skills and cost**
(3) Sawah system agronomic

(a) Water sources for site selection (a) Skills for development

management

At firset, local farmers do not know *sawah* technologies; they know site specific hydrological conditions which are the most important for site selection

(>10 L/s, >5 months/year)

Skill for power-tiller operations

Action research & on-the-job training o n site-specific *sawah* development and management

Rice monocropping

Stream/River, Spring,

Plowing and Pudding

Rice and other 2nd season

Seepage, Flood, Rainfed

Soil Moving

Cropping

(b) Topography and soil

Surface leveling & smoothing

Rice double cropping

for site selection

Skill for power-tiller management

Overall Water Control

Potential area

(b) Cost

Water Sources

Slope and surface

Power -tiller for development

Water distribution

& Roughness

Power tiller spare parts

Leveling

Fuel for development

Soil

& smoothing

(a) Socio-economic for site

Bush clearing, destumping

Bunding

Selection

Bunding and surface treatment

Puddling

Participating farmers

Canal construction

Weed control

Land tenure

Additional hired labour

Water consumption

(b) *Sawah* system design

Water requirement

Sawah layout and total potential area

Water quality

Mean *sawah* size

soil fertility

Water intake, distribution and control

Carbon sequestration

Spring and sawah to sawah

Fertilization

& diversion canal

Stream/Seepage and sawah to sawah

Variety

& diversion canal

Yield

Simple dyke & diversion canal

Cost effective

Weir and Canal

sawah-based

Fish pond, dam lake

rice farming

Pump irrigation

Advanced *sawah*-

Interceptor canal

based farming

Contour bund system

Floods control

by drainage or dam

Drought control by

pond/water-harvest

Soil movement and

leveling

officers

Bund layout and quality

General farmers

On the job collaboration between farmers and Scientists, engineers and extension office is essentially important

Tools and materials

Scientist and engineers cost

Extension officer cost

Farmers' training cost

(4) Farmers Group Quality(N-PO5-K2O)

Leader and group collaboration

No. of farmers

Ethnic composition

Skills and incentive

Gender composition

.

.

(5) Training

Trainer

Trainee

International scientists

National scientsis

Extension

Leading farmers

(1)Immediate target paddy yield >4t/ha

(2)3t/ha is not enough to sustain *sawah* development

(3)>5/ha will accelerate *sawah* development

(4)Basic research on sustainable paddy yield >8t/ha is important

Minimize the personnel cost for development

Target cost: $1000-3000/ha

To train

(1) *Sawah* farmers who can develop *Sawah* and manage *Sawah*-based rice farming by themselves;

(2) *Leading sawah* farmers and farmers' group to train new *sawah* farmer and farmers' group

ASSESSING THE EFFECT OF LAND TENURE SYSTEMS ON THE DEVELOPMENT OF SAWAH AMONG RICE FARMERS IN THE ASHANTI REGION OF GHANA

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ABSTRACT

Systems of land tenure are location specific and cannot be generalized for a particular country, as the diverse social systems at the different parts of the country have specific tenure arrangements. A descriptive survey was conducted in the Ahafo-Ano South, Atwima Nwabiagya and Amansie-West Districts of the Ashanti Region of Ghana to assess the effect of land tenure systems on the development of sawah among rice farmers. The Districts and the respondents were purposively selected. A structured questionnaire validate was administered in 2009. Personal in-depth discussions were also done with some key informants in the districts. The survey showed that, individual lands, family lands, stool lands and rentals, were methods of accessing land for sawah development. Rents were mostly payment in kind, of milled rice at harvest. Tenancy agreements were generally verbal, with at least one year duration. The study revealed that, accessing wetlands for sawah development was not a problem, as natives and settlers have access to wetlands. Land tenure per se was not a major threat to sawah development, though the study showed short term land uses by some of the sawah farmers. However, sawah development and sustainability is dependent on other production and socio-economic constraints mainly; unavailability of funds (40.6%), unavailability of power tillers (40.2%), birds (32%), unavailability of labour for development and transplanting (26.6%), poor markets for produce (21%), lack of inputs (15%) and fertilizer (15%).

INTRODUCTION

The issues of land and land tenure have been cited as accounting for low productivity in Africa. According to ECD (2009), land is at the core of the challenge of triggering a Green Revolution and getting agriculture moving for food security and poverty reduction in Africa, because land is the foundation for agricultural production and rural livelihoods, access to and security of land rights, are prime concerns for policies and strategies aiming at reducing food insecurity and poverty. It is seen as a critical constraint on poverty reduction because most rural households rely on land for the reproduction of future generations, since the industrial and service sectors do not currently provide alternative opportunities for survival.

In West Africa, existing land problems are insecurity of tenure and its effect on the effective exploitation of land rather than, past land expropriation by settlers as it pertains in other regions (Toulmin and Longbottom, 1997). FAO (2002) indicated that land tenure systems determine who can use what resources,for how long and under what conditions. It reported that, issues of access to land and land tenure are of importance, as land tenure plays a vital role in achieving sustainable rural development and increasing technological change and economic integration.

La Anyane (1962) has observed that, perhaps the most important problem of agriculture production in Ghana is that of land tenure arrangement. On the contrary, Osei (1981) stated that the traditional hospitability characteristic of most Ghanaian rural communities makes land acquisition relatively easy for the stranger farmer, although the terms of the grant may sometimes not be in the best interest of the tenant. Kasanga (1988), reports, land tenure is considered a major variable, contributing to the under development of the agricultural sector and has generally been considered as a convenient scapegoat. Nevertheless, systems of land tenure are location specific and cannot be generalized for a particular country as the diverse social systems at the different parts of the country have specific tenure arrangements.

LAND TENURE AND RICE PRODUCTION IN GHANA

Smallholders are the main producers of agricultural products, particularly rice, for family consumption and supply to local and national markets in Sub-Saharan Africa (IVC, 1997).

FAO (2002), indicated that, the ability of the agricultural sector to provide employment competitively with other sectors, depends on various factors including, land tenure.

According to Wakatsukiet al., (2001), access to land becomes a problem to farmers who may not own their own land but have to rent or hire land to farm.Wakatsuki (2002) indicates that, Sawah is the prerequisite for realising the green revolution as well as for preservingand restoring ecological environments. He argues that, the Rice Green Revolution in Africa will materialised only if the “the simple low cost environmentally friendly Asian Sawah technology,” is adopted and used in the inland valley lowlands for increased rice productivity. The Asian “Sawah “technology has the potential to improve the rice growing environment of smallholder farmers by addressing the poor water management problem as a result of excessive flooding and drought through bunding, puddling and levelling for good water control and improve fertility (Wakatsuki, 2004).

In an effort to create sustainable livelihoods for the smallholder rice farmers, by introducing appropriate technologies like Sawah, availability of inland valley wetlands and reasonable tenure arrangements are of primary concern.

THE SAWAH TECHNOLOGY

The Japan International Cooperation Agency (JICA), in collaboration with the Council for Scientific and Industrial Research (CSIR),-Crops Research Institute (CRI), in 1997 introduced “the simple low cost environmentally friendly Asian Sawah technology,” for adoption by the smallholder farmers for managing the inland valleys of Ghana.

The introduction of the Asian Sawah technology by JICA, to Sub- Saharan Africa, has open a new frontier in getting agriculture moving to achieve food security and poverty reduction in Africa.

The term 'sawah' originated from Malayo- Indonesia. “Sawah”, a man-made improved rice field, is a demarcated, levelled, bunded and puddled rice fields with in-lets and out-lets that can be connected to various irrigation facilities such as irrigation canals, ponds, springs or pumps (Wakatsuki, 2008).

The benefits of sawah to be derived by the smallholder rice farmer are numerous. The Asian “Sawah “ technology has the potential to improve the rice growing environment of the smallholder farmers in the inland valleys by addressing the poor water management problems through bunding, puddling and levelling for good water control and improve fertility. The Sawah system offers the opportunity for the technologies of genetic improvements of rice (variety) and the rice growing environment (sawah) to be developed in a good balance for successful Integrated Genetic and Natural Resource Management (IGRNM).

According to, Wakatsuki and Buri (2008), a developed Sawah plot is seen as an infrastructure which is to be used for a long time and Tabuchi and Hasegawa (1995) indicates Sawah is a sustainable rice cultivation system.

Wakatsuki, (2006) reports that, through long history and experiences of “Sawah” based rice farming in Asia, it has been determined that, lowland, “Sawah” can produce about 2.0 t/ha without any application of chemical fertilizer. Asubonteng (2001) also reports of high yields and sustainable production irrespective of fertilizer use, when the sawah technology of, bunding, levelling, puddling and transplanting are adopted.

Yield increases from an average of 1.2 to 5.0 t/h have been achieved on farmers' fields by the Ghana and Nigeria sawah systems (Wakatsuki, 2009 and Issaka et al., 2008).

Again, under submerged conditions, because of reduction of ferric ion to ferrous ion, phosphorus availability is increased and pH is neutralized; hence, micronutrient availability is also increased (Kyuma 2003). Furthermore, the sawah system can contribute to the alleviation of global warming problems through the fixation of carbon by forests and soils (Wakatsuki & Masunage, 2005). Consequently, Wakatsuki (2004) argues that, the Rice Green Revolution in Africa will materialised only if the Asian Sawah technology is adopted and used in the inland valley lowlands for increased rice productivity.

This paper specifically sought to:

- Describe sawah rice farmers in the study area on their demographic and social characteristics.
- Identify access to wetlands in the community by rice farmers.
- Determine the various methods of acquiring wetland for sawah rice production.
- Examine tenancy arrangements available for the sawah rice farmers.
- Ascertain the constraints faced by sawah rice farmers in the community

THE STUDY AREA:

The study was carried out in the Ashanti Region of Ghana in the Ahafo -Ano South, Atwima-Nwabiagy and the Amannsie -West Districts. The region is centrally located in the middle belt of Ghana, with Kumasi as its capital. It lies between, longitudes 0.15W and 2.25W, and latitudes 5.50N and 7.46N. The average daily temperature is about 27 degrees Celsius with a mean monthly temperature of about 26°C. The rainfall pattern is bimodal.The mean annual rainfall ranges from, 150 to 170 cm, with a high relative humidity. The major season starts in mid-March to July, with the peak in June and a short dry spell in August. The minor season starts in September and ends in mid- November. The vegetation is semi-deciduous rain forest.

METHODOLOGY:

A descriptive survey was conducted in the Ahafo-Ano South, Atwima Nwabiagya and Amansie-West Districts of the Ashanti region in 2009. Multiple methods of data collection were used to provide reliable and valid data (Philips, 1998). The questionnaire was administered to a small group of rice farmers to pre-test it and the content and face validate were also ensured.

POPULATION SAMPLING:

The population for the study were the smallholder rice farmers, Land owners, the District Director of Agriculture (DDA), the District Development Officers (DDOs) and Extension Agents (AEAs).The local extension office helped to select a total of 70 practising Sawah farmers, from Ntensere (Sokwae)-14; Biemso No1-22; Adugyama- 13; Amakom- 6 and Maanukrom- 4.

The districts, communities and sawah farmers were purposively selected because these were the areas where the sawah technology was introduced and is being practised and the sawah rice farmers were the ones who could give us the needed information. In-depth discussions with key informants such as Land owners, the District Director of Agriculture (DDA), the District Development Officers (DDOs) and Extension Agents (AEAs) were carried out to gather qualitative information.

Data were analyzed with Statistical Product for Service Solutions (SPSS) Version 15,using descriptive statistics.
69 out of the 70 farmers were interviewed using the validated questionnaire. One female farmer was delivered of a baby and could not be interviewed.
Results and Discussion

Table1: Demographic Characteristics of the Farmers

Variables	Frequencies	Percentages (%)
Age (Years)		
21-30	11	15.9
31-40	26	37.7
41-50	19	27.5
Over 50	13	18.8
Gender Distribution		
Male	47	68.1
Female	22	31.0
Level of Education		
No formal education	25	36.2
Primary education	14	20.3
Junior secondary School	19	27.5
Senior Secondary School	8	11.6
Tertiary	3	4.3
Residential status		
Native	15	21.7
Settler	54	78.3
Experience in rice cultivation(Years)		
<5	13	18.8
6-10	24	34.4
11-15	18	26.1
16-20	9	13.2
Over 20	5	7.2
Farm Size (ha)		
Up to 0.50	47	68.1
0.06 – 1ha	12	17.4
Over 1	10	14.5

Source: Field Survey 2009

The average age of the farmers was 41.2 years witha standard deviation of 10.78. Majority (81.1%) of the respondents were between 21 and 50 years, whilst 18.8% were over fifty years. The majority (68.1%) of the sawah farmers were men and 31 % were women. Farmers with only primary and junior secondary (formally middle school) and senior secondary education made up the majority (59.4%). Only a few (4.3%) had tertiary, whilst (36.2%).had no formal education. Majority of the farmers (78.3%) were settlers, whilst 21.7 % were natives. The natives are the indigeneous Ashantis, who have always lived in the village and the settlers are immigrant who came from the northern parts of Ghana to work mainly as farm hands. The majority (73.9%) had rice cultivation experiences ranging between 6 and 20 years, while 7.2% had over 20 years experience. Farmers with farm sizes of up to 0.50 ha, formed the majority (68.4%). Farm sizes bigger than 0.50 to 1.0 ha made up 17.4% and14.5% had above 1 ha.

Access to Wetlands for Rice Cultivation

Table 2: Accesses for Natives and Settler

Variable	Frequency	Percentages
Natives	34	49.3
Settlers	31	44.9
Migrating Farmers	4	5.8
Total	69	100

Source: Field survey (2009).

A slim majority (49.3%) of respondents indicated that natives have access; and 44.9% indicated settlers have access. However , only 5.8% of the respondents indicated that migrating farmers also have access to wet lands in the communities. Seasonal migration of traditional rice farmers from different communities into the study are as to access wetlands for rice cultivation was observed at Ahafo-Ano South and Atwima Nwabiagya Districts. Under the 'customary law freehold' these migrating farmers are able to access wetlands from the sub stool, families or individuals. Osei (1981) stated that, "The traditional hospitalitycharacteristic of most Ghanaian rural communities makes land acquisition relatively easy for the stranger farmer, although the terms of the grant may sometimes not be in the best interest of the tenant"

METHODS OF ACQUIRING WETLANDS FOR SAWAH RICE PRODUCTION

Table 3: Land Acquisition Methods

Variable	Frequency	Percent (%)
Own	**6**	8.7
Maternal inheritance	1	1.4
Rentals from Chief	39	56.5
Rentals from Family head	22	31.9
Total	69	100.

Source: Field survey (2009).

Table 3 depict percentage distribution of the sawah rice farmers' methods of acquiring wetland for sawah development. When the farmers were asked how they acquired their wetlands in the community for the sawah development project, a majority of them (88.4%) rented their wetlands for sawah rice production. Rentals from chiefs made up 56.5%, whilst 31.9% were rentals from family heads. Sawah farmers who own their wetlands were 8.7%. Acquisition of wetlands by maternal inheritance was 1.4%.None of the farmers had access to the wetland by patrilineal inheritance, sharecropping or allocation by government. All the wetlands operated by the farmers' were family and stool lands. This may be explained by Kasanga's (1988) report that, in Ghana, direct traditional landholding is over 90% of the total land area of 92.100 square miles. Sarpong (2006) estimated that 80% of Ghana's lands are held under customary land tenure systems.

Consequently renting of wetlands by the settlers who are not natives of the village from individual land owners and the chiefs are accepted methods of acquiring land for farming in rural communities. This finding is similar to Kasanga (1998), who reports that locals strangers do not have communal rights in land.

About 9% of the farmers were owner-occupiers with the right of use, right of control and right of transfer. This has very favourable implications for sawah development and sustainability, as sawah needs secured tenure arrangements for long term land use to enable the farmers reap the benefits of their toils, as investment in sawah is both labour and capital intensive. Nature and Characteristics of Farm Tenancy Arrangements in the Study Areas.

NATURE AND CONDITIONS OF TENANCY

A concern of the study was to examine tenancy arrangements available for the Sawah rice farmers because systems of land tenure are location specific and cannot be generalized for a particular country as the diverse social systems at the different parts of the country have specific tenure arrangements. When asked what tenancy agreements they have contracted, a majority (65.2 %) responded they have verbal agreements, 11% had written agreement and 18.8% had no agreements.

The large proportion of the sawah farmers having verbal agreements may be attributed to the findings from the study that, a substantial 40% of the farmers were novices who have just started sawah farming or had only one year experience and may be in the process of negotiation for long term land use, a transition from traditional rice farming to sawah. In the traditional rice farming, the term of tenure is very short, with a lot of uncertainties, tenants move to different sites in search of fertile lands seasonally, so tenant- landlord contact is short, therefore the verbal arrangements are normal and is adequate for the period.

According to Sarpong (2006), tenure insecurity in many customary transactions is largely the result of absence of written documentation on and uniform units of measurement for land transactions. The implications for the project is that, with the tenure insecurity and risk associated with verbal agreements, it is of primary importance that systems are put in place to assist in negotiations for secure long term land use rights for the farmers for sustainability.

FORMS OF TENANCY AND CONDITIONS OF RENT

Fixed rent was the form of tenancy contract practiced by all the farmers except at Maanukrom, a Millennium Village Project (MVP) in the Amansie -West District, who are “rent free”. Fixed rent involves a fixed amount of rent either in cash or kind, which was to be paid irrespective of actual production (Fujimoto, 1996). The quantities of milled rice paid as rent differed from community to community and from landlord to landlord and was influenced somehow by the tenant-landlord relationship. Fujiimoto (1996)observed same and reported that, the level of agreed rent, however vary considerable from one community to the other, reflecting various complex factors including demand for land, productivity and landlord-tenant relationship. Basically, it was observed in all the three districts that, the unit of measurement was not by weight but by volume. The farmers used a container they referred to as “tin”. According to the Local Extension Agent in the Ahafo-Ano South District, “one tin” is equivalent to 35 kilograms of milled rice. A landlord may charge one “tin”, two “tins” or more depending on farm size. When asked if the natives and settlers have equal agreement conditions, majority (82.6%) said yes and 17.4% said ‘No’. Considering the fact that the natives do not contract tenancy agreements, the responses given therefore are in favour of the settlers who make up the bulk of the sawah farmers and it is a good indication of sawah sustainability.

Another observation was that in the traditional setting, the size of the wetlands was not measured in acreages for the farmers; the land owner just agreed on the number of “tins” to be paid as rent and the farmer can farm as much as he can.This was somehow to the advantage of the farmers who could cultivate bigger plots. Nevertheless, the majority of smallholders in the wetlands have farm sizes ranging from 0.02 – 0.5ha. Production and Socio Economic Constraints Militating Against Sawah Rice Production

Table 4:Constraints to Sawah Rice Production

Variable	Percent (%)
Lack of access to credit	40.6
Unavailability of Power Tiller	40.2
Unavailability of labour	26.6
Poor Marketing	21
Initial land preparation	19.6
Unavailability of inputs	15
Unavailability of fertilizer	15
Birds	10
Disease and Pest Control	9.4
Lack of tarpaulin/ drying platform	8.2
Weeds	8
Lack of access to improve seed	2.4

Source: Field survey (2009).

The farmers were asked to rank the constraints in the order of importance by listing the most predominant constraints first and then the minor constraints in sawah development.

The initial sawah development involves bunding and levelling for good water management, which involves a lot of soil movement. It is labour and capital intensive and farmers need to be given assistance in form of credit and other production input. Power tiller is the main equipment used in land development, therefore its availability and training of operators to handle the equipment is very essential. Fashola et.al (2006) reported in Nigeria, on the need for more trainers on Sawah system development, more power tillers and power tiller operators and maintainers, technology on small scale farm mechanization and its operation and maintenance. The other constraints identified include, short term land use, poor market facilities, poor water management, birds, weeds, diseases and pest control. There is the need to address these constraints identified for increased productivity.

Kranjac-Berisavljevic et al (2003), Norman and Kebe (2006)madee reports of various constraints faced by rice farmers such as high incidence of pests, weeds and diseases, drought and poor water control, poor seed management, poor soil fertility management, lack of access to credit, farm inputs, farm machinery, animal traction and shortage of labour.

CONCLUSION

Access to wetlands for sawah development is not a problem for the settlers are landless and form the bulk of the sawah rice farmers, because both natives and settlers have equal access. Renting from stools/sub stools and individuals was an accepted mode of acquiring wetlands for sawah development in the communities. The tenure arrangements and terms of conditions, though were location specific, were favorable for the farmers in all the three districts. The findings have shown that land tenure per se is not a major threat to sawah development and sustainability but other production and socio-economic constraints; the predominant ones being unavailability of funds, unavailability of power tillers, unavailability of labour for land preparation and during transplanting, supply of inputs with emphasis on fertilizer.

RECOMMENDATIONS

From the foregoing, it is recommended that, the Sawah Project collaborates with the Rice Project teams of the Districts Agriculture Extension Offices, to from Land Negotiation Teams, which will consist of the Extension staff, farmers and other key stakeholders to negotiate on behalf of sawah farmers.

The negotiation would discuss a well laid out agreement between the land owner and the settlers. It would determine the land owner's commitment toward the improvement of the land. A well discussed agreement for both parties should be signed to ensure security on the part of the tenant and satisfaction for the land lord. This will ensure fair rent charges and good tenant-land lord relationship and long term land use for sustainability.

There is the need to build farmers capacity through training in operation of small-scale farm machinery such as power tillers and water pumps. It is recommended that, farmers are assisted to access credit from formal credit institutions and also be linked to Agro chemical and input dealers to ensure timely supply of inputs particularly, fertilizer for increased rice productivity in Ghana.

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APPROPRIATE RICE/MAIZE SPATIAL INTERCROPPING SYSTEM FOR NERICA PRODUCTION

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ABSTRACT:

An evaluation of Rice/maize spatial arrangements were conducted in field experiments at Emitsu Ndadan, near Doko Central Nigeria in 2008 and 2009. The objective was to study the productivity of component species in the mixture. The treatments were Rice/maize (3:1), Rice/maize (5:1), sole maize and sole rice. The spacing for rice and maize were 25.0cm x 25.0cm and 75.0cm x 20.0cm respectively. FARO 55 and IWDC – SYN maize variety were used as test crops. The trials were replicated in five sites/locations within the area. Data were collected on the yield and some yield components of the test crops which were analyzed by means of ANOVA. Rice grain yield, Pan/$m^{2,}$ and maize plant height as well as grain yield were affected by spatial arrangements.

The highest and the least grain yields of 2.66 t/ha and 1.68 t/ha were obtained with sole rice and 3:1 rice/maize mixture respectively. Maize yields followed exactly similar pattern. The LER of 1.92 and 2.06 for the 3:1 and 5:1 rice/maize shows the efficiency in land use in the intercrops than the sole crops.

INTRODUCTION

The benefit of intercropping defined"as growing of two or more crops simultaneously on the same piece of land" (Srinivan, 1990) as oppose to sole cropping, are numerous. These include harvesting of diverse crops from the same land, increased total land productivity and risk against crop failure due to weather (Hoque, 1984 and Norman et al., 1981) and efficient utilization of resources (Okigbo and Green Land, 1976). Rice/maize intercrop is a popular practice among the resource poor farmers in Nigeria, under diverse production systems with respect to land preparation, plant population and spatial arrangement (Bakare et al, 2004). The ratio of rice to maize depends on the interest of the farmers. Research has recommended 1:7 rice: maize or sorghum and 1:3 for farmers whose interest are on sorghum or maize and those for rice respectively (Bakare and Adagba, 1997; Adepoju et al, 1998). Since most small scale farmers practices are diverse, there is need to evaluate recommended practices at the on-farm level to increase rice/maize productivity and farmers income, which is the objective of the present study.

Methodology

The study area

The environmental features of the study area are presented in table 1.

Field Experiment

The test crops were FARO 55 and IWDC – SYN for rice and maize, respectively. Experimental design was RCB and replicated three times. Plot size was 4.0m x 3.0m ($12M^2$). The spacing for rice and maize are 25.0cm by 25.0cm and 75.0cm x 20.0cm inter and intra-rows, respectively. The same population was maintained for the soles and intercrops. All agronomic practices namely, fertilizer application and weeding were appropriately carried out. Data were on the growth parameters of rice and maize and analyzed using ANOVA and LSD.

RESULTS AND DISCUSSION

The result of soil test of sample from the experimental site is shown in Table 2.

The effect of spatial arrangements on the productivities of the component species in rice/maize mixture is presented in tables 3 and 4, for rice and maize respectively. With respect to rice, germination count, plant height, tiller numbers and days to 50% flowering were not statistically affected by the spatial arrangement. Sole rice gave the highest Panicle/m^2 of 129. The effect of spatial arrangement on the productivities of rice and maize in rice/maize mixtures are presented intables 5 and 6, respectively. With respect to the mixtures, there was no definite trend for both years, as the yield increase oscillates between the treatments. The highest rice grain yield (2.66 t/ha) was obtained under sole rice in 2009 at site 1, while the least yield (1.68t/ha) was recorded in 2008 at site 4.

For maize, the yield exhibited the same trend as was the case with rice. The highest maize grain yield (5.3 t/ha) was recorded in 2009 at site 4 under sole maize, while the least (3.7 t/ha) was obtained in 2008 at site 3, with rice/maize in the ratio 3:1.

Although sole crops of rice and maize gave the highest yields in 60 % of the entire scenarios, the Land Equivalent Ratio (LER) of 1.92 and 2.06 for the 3:1 and 5:1 rice/maize, respectively over 1.0 for the sole crops which clearly indicated efficiency of land use under the intercropping system than the sole crops.

Although, there was no data on pests and diseases, there appears to be some synergy in terms of protection against damage when the crops were intercropped than in sole cropping. The reason may be responsible for the lower yields of crops when planted as sole. Also, the partial shading of rice crop which form the lower strata by the maize, may have regulated the micro-climate (reduced temperature, reduced evapo-transpiration and possibly, increase soil moisture), some of which could inhibit rice performance, especially moisture for upland rice.

CONCLUSION

The highest and the least grain yields of 2.66 t/ha and 1.68 t/ha were obtained with sole rice and 3:1 rice/maize mixture respectively. The LER of 1.92 and 2.06 for the 3:1 and 5:1 rice/maize shows the efficiency in land use in the intercrops than the sole crops.The choice of 3:1 or 5:1 should depend on the interest of the farmer.

Table 1: Environmental characteristics of the study area

Parameters			Characteristics/Values
1.	Agro-climatic zone	:	Sub-humid
2.	Agro-ecological zone	:	Southern guinea savanna
3.	Geographical coordinate:		
	Long	:	$6^0$01'E
	Lat	:	$9^0$02'N
4.	Length of growing period	:	
	(Days)		181 – 200
5.	Total Annual Rainfall (mm)	:	1,200 – 1,500
6.	Rainy season	:	June – October
7.	Mean Temperature	:	$23^0 – 25^0$C
8.	Evapo-transpiration	:	950 – 1,300
9.	Solar Radiation	:	15
10.	Rainfall pattern	:	Bimodal
11.	Soil Type: USDA	:	Arenic paleustalf
	UNESCO	:	Haplic Acrisol
12.	Geology	:	Nupe sandstone

Table 2: Soil test values of the experimental site

S/No	Parameter		Value
1.	Sand (%)	=	70.7
	Soil (%)	=	2.0
	Clay (%)	=	27.3
2.	Nitrogen (%)	=	0.03
3.	Organic – C (%)	=	2.51
4.	Total – P (Bray P1) (DPM)	=	0.83
5.	Exch K (meq/100g)	=	1.25
	Ca (meq/100g)	=	2.1
	Mg (meq/100g)	=	8.4

Table 3: Effect of spatial arrangement on the productivity of rice in rice/maize Inter-crop at Emitsu-Ndadan, Doko in Central Nigeria (2008).

Treatments	Germination Count (%)	Plant height (cm)	Tiller No/stand	Days to 50% flowering	Pan/m^2	Grain yield (t/ha)
Rice/maize (3:1)	95.1	91.1	21.0	74.0	124 b	2.61 a
Rice/maize (5:1)	90.0	90.3	24.3	74.0	115 c	2.44 a
Sole Rice	96.4	89.2	24.6	73.5	129 a	2.01 b
Sole maize	-	-	-	-	-	-
S.E (T) =	0.31	0.88	2.62	0.93	11.7	4.55
S.E (R) =	0.53	1.01	3.02	1.2	13.5	5.25
LSD (5%) =	NS	NS	NS	NS	0.33	0.41
C.V (%)	6.3	2.1	7.7	2.6	18.3	10.4

Table 4: Effect of spatial Arrangement on the productivity of Maize in Rice/maize intercrop at Emitsu-Ndadan, Doko in central Nigeria (2008)

Treatments	Germination count (%)	Plant height (cm)	Days to 50% flowering	Cob No/plant	Grain yield (t/ha)
Rice/maize (3:1)	93.6	193.4	53.0	2.0	4.41 b
Rice/maize (5:1)	97.2	199.4	53.7	2.0	4.90 a
Sole Rice	-	-	-	-	-
Sole maize	89.1	203.2	53.3	1.6	4.0 c
S.E (T) =	0.55	2.05	0.81	0.38	0.21
S.E (R) =	1.46	2.37	0.94	0.44	0.24
LSD (5%) =	NS	1.45	NS	NS	0.36
C.V (%)	6.30	2.03	1.2	2.2	1.11

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ADOPTION OF THE 'SAWAH' SYSTEMFOR INCREASING AND SUSTAINING RICE PRODUCTION IN THE INLAND VALLEYS

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ABSTRACT

In Ghana, rice production has been influenced by various kinds of policies since 1960. Favourablepolicies resulted in self-sufficiency in rice production between1974 and 1975. Liberalization system in the 1980s brought about significant reduction in the production of the crop resulting in large deficits. Presently, rice production in the inland valley is mostly by traditional methods which are characterized by poor water control, serious erosion into streams and rivers and ultimately poor yields. Grain yields generally range between 1.0 and 2.0 t/ha. The “sawah' system of rice production is gradually gaining grounds in some districts in Ghana but needs more out-scaling and be supported by effective policies that will enhance its adoption. In addition to high paddy yield (5.0 to 7.0 t/ha), this technology is environmentally friendly and easy to manage by farmers, once the 'sawah' fields are established. Introduction of large irrigation schemes in these valleys will result in serious environmental problems. The need to increase rice production while maintaining a sound environment, calls for an appropriate technology for rice production in the inland valleys of the country. To ensure proper and efficient use of these inland valleys, there is a need for policy that will direct the system of rice production in these environments. The 'sawah system of rice production satisfies both areas of sound environment and high rice yields.

INTRODUCTION

In Ghana, the potential area for small scale irrigated sawah in inland valleys is estimated at 700,000 hectares (JICA/CSIR-CRI, 2000; Wakatsuki, 1994). There is substantial potential for increasing production through increased productivity. Yields of most crops can be increased substantially through application of improved technology such as timely and proper application of fertilizers, adequate weeding, use of improved seeds and seedlings, use of proper cultural practices of crop and animal husbandry and use of the 'Sawah' system of rice production in the inland valleys.

Introduction of the 'Sawah' technology (bunded, puddled and leveled rice field with irrigation and drainage facilities) to farmers in parts of Ashanti region saw significant increase in their rice yield (Buri, 2008). Rice yield of farmer groups introduced to Sawah increased from an average of 1.0 t/ha to over 4.0 t/ha in the first year. Significant variation in rice yield under different rice environments, using Sikamo as a test crop, has been reported (Issaka et al., 2001, Issaka et al., 2010). Puddling does not only control weeds and ease transplanting but retains water by reducing rate of percolation (De Data, 1981). This action ensures that water is available for rice growth and development.

METHODOLOGY

Information was, generally, collected from secondary data.

Results and Discussion

Policy orientation and rice production: Presently,large amounts of rice are consumed in Ghana. Demand for rice far outweighs local production. Over 60% of rice consumed is imported. Over the years, policy direction influenced rice production significantly. Between 1960 and 1970, rice importation was restricted. To encourage production, fertilizer and agricultural machinery were heavily subsidized (60-86%) (NRI/ISSER,1998; Agrey- Fin, 1999; MoFA, 2003). The country became self sufficient in rice from 1974 -75. In the 1980s, policy direction shifted fully to a liberalized system, demand for fertilizer fell significantly, resulting in a sharp fall in production. A decrease in tax on imported rice in 2001 made imported rice cheaper and large quantities were imported into the country. High cost of rice production made local rice more expensive than imported ones.Consequently, many farmers went out of business and less land was put under rice cultivation (Figure 1).

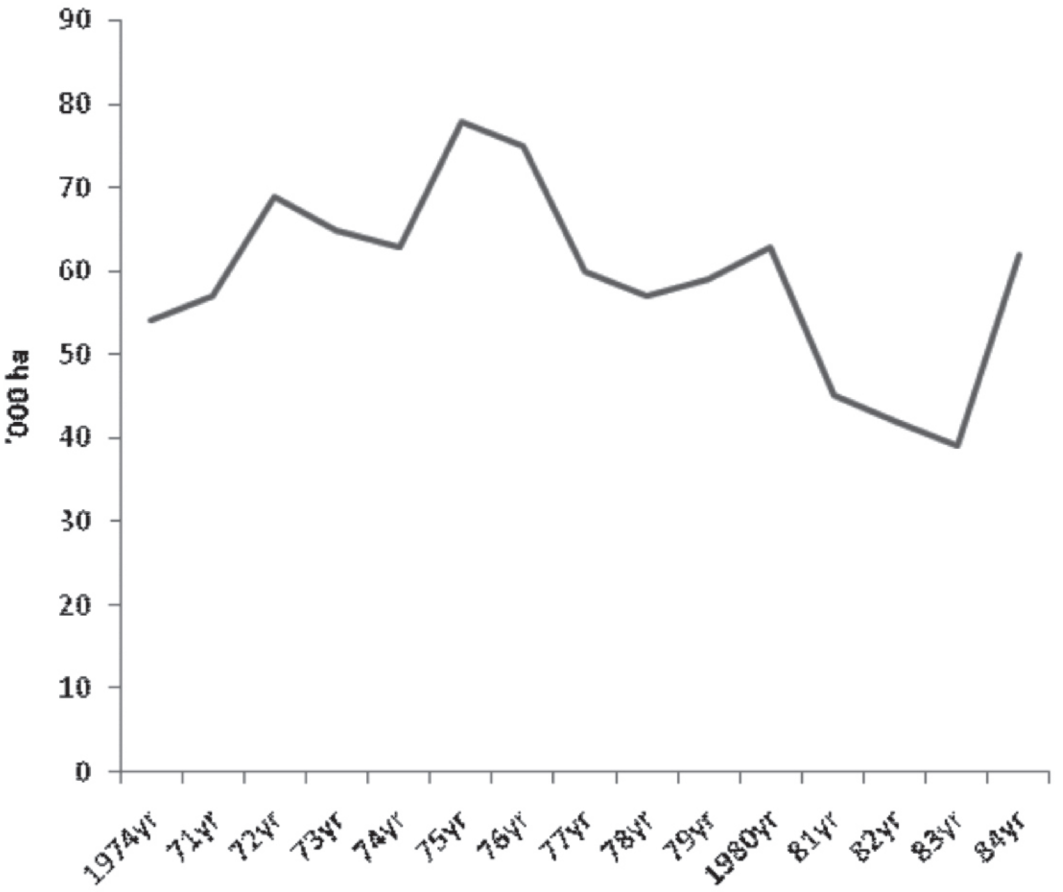

Fig. 1: Changes in area under rice cultivation from 1970 – 1984

Technologies for rice production in the country: There are three broad systems of rice cultivation in Ghana:- Irrigated rice, upland rice and rice cultivated in inland valleys. Paddy yield under irrigation, upland and inland valleys are presented in Table 1. Rice yield under irrigation is generally higher (4.5 t/ha), followed by inland valley (2.4 t/ha), with upland rice having the lowest yield per unit area (1.0 t/ha).

Table 1: Typology of rice productionsystems and their contributions to rice production in 2002.

	Irrigated	Upland	Inland Valley	Total
Area (ha)	10,200	18,750	93,750	122,700
Paddy Yield (t/ha)	4.5	1.0	2.4	
Production (t)	45,900	18,750	225,000	289,650
% of total production	16	6	78	

Source: MOFA (2003) and Agrey-Fin (1999).

In Ghana, inland valleys occur throughout the country and have a huge potential as rice production ecology (JICA/CSIR-CRI, 2000). Many inland valleys are annually used, largely for rice production and to some extent, vegetables. Rice is normally grown using traditional methods where water management is almost non-existent and fertilizers ararely used (Haleegoah, 2001; JICA/CSIR-CRI, 2000). Improper use of these valleys for rice production results in a gradual but steady siltation of streams and rivers. Paddy yield is, also, generally low, ranging from 1.0 – 2.5 t/ha. To arrest this situation, ecological sound management practices need to be adopted.

Sawah system of rice production

"Sawah" is defined as bunded, puddled and leveled rice field, with inlets for both irrigation and drainage. "Sawah" has an intrinsic resistance to erosion and self enriching in some major nutrients (Table 2). Many studies on the use of 'Sawah' for rice production in Ghana have been done. This range from description of various 'Sawah' systems (JICA/CSIR-CRI, 2000), rice agronomy (Buri et al, 2004, Issaka, et al. 2009), nutrient status of inland valleys (Buri et al. 2009, Senayah et al, 2008, Issaka et al 1997) and general development of inland valleys into 'Sawah'. The introduction of 'Sawah' in the Ahafo Ano South district saw a significant increase in rice yield in that district (Table 3)

Table 2: Evolution of soil properties under various soil management practices.

Parameter	Initial soil properties	Farmers' Practice 2006	2007	Bunded Non- leveled 2006	2007	Bunded & leveled 2006	2007
Soil pH	5.3	5.2	5.0	5.4	5.5	5.5	6.1
Organic carbon (g kg^{-1})	15.4	15.6	16.5	15.8	16.8	15.6	16.5
Total nitrogen (g kg^{-1})	1.40	1.32	1.38	1.42	1.46	1.52	1.55
Bray No. 2 P (mg kg^{-1})	3.50	2.40	3.20	3.60	3.50	4.20	4.90
Exch. K [cmol(+) kg^{-1}]	0.04	0.03	0.03	0.05	0.08	0.09	0.14
Exch. Ca [cmol(+) kg^{-1}]	4.20	3.86	3.55	4.35	4.67	4.65	5.50
Exch. Mg [cmol(+) kg^{-1}]	2.10	2.00	1.85	2.30	2.25	2.35	2.45
ECEC [cmol(+) kg^{-1}]	6.24	5.89	5.43	6.70	7.00	7.09	8.09

Expansion of "Sawah": A Japanese sponsored project- JICA/CSIR Sawah Project was introduced at Adugyama in the Ahafo Ano South District in the Ashanti region. The project focused on both research and on-farm adoption of the 'Sawah" system. At the end of the project, a similar effort between Shimane University and CSIR-Soil Research Institute, led by Prof. T. Wakatsuki out-scaled the technology. Farmers were supported and trained to develop their rice fields into sawah.

After out-scaling of sawah to many villages in Ahafo Ano South district and beyond under the Prof. Wakatsuki Project, more villages benefitted from a new project introduced by JIRCAS. Many extension officers in the Ahafo Ano South andNwabiagya districts were trained in 'Sawah' development and maintenance. Many farmer groups (e.g. Adugyama, Biemso no. 1, Nsutem, Baniekrom) have, also, been trained in 'Sawah' development, maintenance and power tiller operation.

Presently, there is a wealth of both technical information and human resources for the expansion of 'Sawah'.

Table 3: Rice production in selected districts in Ashanti region in 2000.

District	Area (ha)	Yield (t/ha)
Amansie East	232	1.36
Amansie West	96	1.45
Ahafo Ano South	486	5.50*
Ahafo Ano North	89	1.60
Sekyere West	28	2.30
Sekyere East	44	1.60
Afigya Sekyere	34	1.25
Atwima	1,425	2.90
Offinso	110	1.25
Kwabre	16	1.00

Source: MOFA 2001. * Farmers introduced to 'Sawah' technology

Policy orientation: 'Sawah' system of rice production in inland valleys

For quick adoption and up-scaling of 'Sawah' technology, there is an urgent need to have a policy on the development of inland valleys in Ghana, based on the 'Sawah' system. An initial policy dialogue meeting on use of the 'Sawah' Technology for the development of inland valleys should bring together a range of stakeholders including researchers, policymakers, civil society organisations and media specialists to share their expertise and experience and develop policy recommendations. The meeting should be co-hosted by the Ministry of Agriculture and Food (MOFA), Council for Scientific and Industrial Research (CSIR) and a major donor organization, Japan International Research for Agricultural Sciences (JIRCAS), JICA and Africa Rice.

The main objectives of this policy dialogue are to share knowledge, receive feedback on research findings, understand the challenges that exist for translating policy research into action on the ground and explore ways of collaborating to find solutions. The dialogue would enable participants to review and build upon research conducted by Universities of Shimane/Kinki-Soil Research Institute, JIRCAS-SRI/CRI and MOFA/JIRCAS-SRI/CRI to address issues concerning the 'Sawah' technology.

In addition to this, Kinky University-SRI, JIRCAS/MOFA-SRI/CRI, with experience in supporting farmers to develop their valleys, based on the 'Sawah' system, must streamline and share their views on what is needed to promote rice production using the 'Sawah' Technology in Ghana.

CONCLUSION

With the availability of both technical and natural resources, it is an ideal time to have policy direction for sustainable rice production in Ghana. It is abundantly clear that the 'Sawah' system of rice production is environmentally friendly, in addition to high rice yield. This system of rice production is a key to self sufficiency in rice production in Ghana.

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INTENSIFYING AND SUSTAINING RICE PRODUCTION IN INLAND VALLEY ECOSYSTEMS IN GHANA

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ABSTRACT

The designing and implementation of comprehensive and integrated soil management programs that will not only improve and maintain soil fertility but, also, make maximum use of available water are necessary. Soils of most valleys are dominant in low activity clay minerals which have low nutrient and water holding capacities. Addressing these problems led to the development and introduction of improved water management, nutrient build up and environmentally friendly technology ("Sawah") that will enhance and sustain production. The "Sawah" technology is characterized by nutrient replenishing mechanisms with intrinsic resistance to erosion (better water control and nutrient management). Rice responds better to mineral fertilizer and organic amendments under "sawah" than the traditional system of rice production in Ghana. Rice cultivation under the "Sawah" system in inland valleys in Ghana has led to significant improvement in soil and water management. There has been a gradual increase in rice grain yield in the order: farmers practice < only bunded < bunded and puddled < bunded, puddle and leveled, across varieties and locations. From an initial mean paddy grain yield of 4.5 t ha^{-1} during the first year of introduction in 2001, mean paddy grain yield under the new system consistently increased annually and currently stands at over 6.0 t ha^{-1} among farmer groups. Net income generated per hectare under the new system also ranged from US $528 to US $3000. Even though there was a net loss of both total N and available P over the period, there was an accumulation of total carbon and exchangeable bases (K. Ca, Mg), leading to improved nutrient levels.

INTRODUCTION

In tackling the problem of poverty reduction, food security and minimizing environmental degradation among others, rice is one crop that can be effectively used under improved technological innovations in order to create wealth. In Africa, human-induced climatic change threatens agricultural productivity. According to UNU-IAS (2008), degradation of natural resources reduces the productivity of the poor, who mostly rely on these resources. Understanding the link between livelihoods and managing essential services provided by natural ecosystems is critical for achieving sustainable economic growth and poverty reduction. The same report continues to state that, while Africa is facing diminishing agricultural stocks, high food prices and decreasing productivity, environmental stability is at the same time being lost.

Over 60% of the annual rice requirements of most West African countries, including Ghana is imported even though the sub-region has rice growing environments (Inland valleys, flood plains, etc), that when well managed, will ensure and sustain enough rice production for the West African sub-region and even for export (Andriesse et al, 1995; Wedmeijer & Andriesse, 1993, Wakatsuki T., 1994; Wakatsuki et al, 2004, 2006). Lowlands, particularly flood plains and inland valleys, have been identified as the ecologies that offer considerable potential for agricultural intensification and diversification because double cropping in a year is possible using residual soil moisture. In Ghana, rice is now competing with other crops such as citrus, oil palm, cocoa, mango and vegetables in lowland crop cultivation (Buri et al., 2010). Poor water management and the inherent low fertility status (Buri and Wakatsuki, 1996; Buri et al ., 1998; 1999; Issaka et al ., 1996a, b, 1997) of these lowlands have been identified as the major causes for low rice yields and low crop productivity. Some reasons leading to such concerns may be traced to lack of sound management of our soil resources and possible unsuitable crop production systems and practices.

Effective nutrient and water management and land preparation options, are, however, lacking for the effective and sustainable utilization of these valleys. There is therefore the need for the designing and implementation of a comprehensive and integrated soil management program to provide information on improving and maintaining soil fertility, while making maximum use of available water.

With the development and introduction of the “Sawah” technology to farmers in Ghana, this paper looks at the impact this improved technology has made on nutrient management, rice grain yields and economic returns towards poverty reduction, food security, rural employment and improved standard of living for rice farmers when adopted on a national scale

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MATERIALS AND METHODS

After the development and introduction of the “sawah” technology to farmers in selected villages in the Ashanti region, further research activities on nutrient management and land preparation continued. Simultaneously, production activities of some farmer-groups were regularly monitored at Adugyama, Biemso, Fedeyeya, Nsutem, Asoadei, Baniekrom villages, all located within the semi-deciduous forest zone with an annual rainfall regime of 800–1000mm. Paddygrain yields of five farmer-groups and the soil fertility levels of their rice fields were monitored over a period (2001-2008). For each year, farmers were assisted (on-the-job training and provision of technical services) to adopt the “sawah” system. At harvest, grain yield samples were collected for yield estimation for each farmer-group. For income estimation, actual grain yield, as realized by farmers, was monitored with the assistance of farmer-group executives, who provided yield figures (in bags) and cost of inputs used. Actual grain yield and cost of production was then calculated based on a unit area for each farmer-group. Soil samples were collected annually from each site for laboratory analysis to determine fertility levels. Soil analysis was by the methods described by IITA (1979).

Results and Discussion

There exist a variety of soils within inland valley ecosystems in the West African sub-region. The most commonly recognized ones include Gleysols, Fluvisols, Plintosols, Planosols and Lixisols. These soil types have variable characteristics depending on valley type and location. Lowlands within the sub-region are therefore composed of heterogeneous soils that require different fertility and water management options. Buri et al (2010) indicated that most inland valleys ecologies in Ghana especially those within the savanna agro-ecology were very deficient in most soil nutrients (Table 1) particularly, available P (mean levels < 1.5 mg kg^{-1}), where levels for most areas was almost negligible. The authors therefore recommended that under intensification and for sustainability, effective nutrient and water management options are necessary.

Table 1: Soil nutrient levels of lowlands in Ghana in comparison with West Africa and paddy field of South East Asia

Parameter	Ghana lowlands	West Africa lowlands	Paddy fields of S. E. Asia
pH (water)	5.2	5.3	6.0
Total Carbon (g kg^{-1})	9.1	12.3	14.1
Total Nitrogen(g kg^{-1})	0.88	1.08	1.30
Available Phosphorus (mg kg^{-1})	3.2	8.4	17.6
Exch. Calcium {cmol (+) kg^{-1}}	4.77	2.8	10.4
Exch. Magnesium {cmol (+) kg^{-1}}	2.55	1.3	5.5
Exch. Potassium {cmol (+) kg^{-1}}	0.32	0.3	0.4
eCEC {cmol (+) kg^{-1}}	8.55	5.8	17.8
Clay (g kg^{-1})	97	230	280

As a result of the poor nature of lowlands, particularly inland valleys in Ghana, there was the need to establish or develop effective but cheaper and easier to adopt technologies that are environmentally friendly. To maintain and sustain yields, there is the need to balance biotechnology (improved varieties) with eco-technology (improved growing environment). This led to the development and introduction of the "sawah" technology. Under "Sawah", lowland soils in Ghana have been observed to respond significantly to fertilizer additions (organic and inorganic). Buri et al., (2004) observed significant increase in paddy grain yield when both mineral fertilizer and organic amendments were either used solely or in combination (Tables 2 and 3). Table 2 clearly shows how the omission of any of the major nutrients can significantly affect rice grain yield in inland valley ecosystems. The development of technologies that lead to both increased nutrient and water use efficiency are therefore critical to the continued use of these valleys and this is the void the "sawah" technology has come to fill. Table 3 also shows how effective local soil nutrient amendments can significantly contribute to increased rice grain yield under improved nutrient and water management technologies ("sawah"). Buri et al., (2004) therefore recommended that for effective nutrient management in the lowlands, organic amendments which are easily available and at a lower cost should be considered in any nutrient management program.

Table 2: Effect of nutrient omission on lowland rice grain yield in Ghana

Treatment/Site	Adugyama		Biemso	
$N-P_2O_5-K_2O$ kg ha^{-1}	2004	2005	2004	2005
0 - 90 – 90	1.29	1.48	1.39	1.47
90 - 0 – 90	2.03	2.08	1.99	2.04
90 - 90 – 0	3.09	2.31	2.75	2.53
90 - 90 – 90	6.84	6.89	7.07	7.11
S.E	1.23	1.25	1.29	1.29

Table 3: Effect of integrated nutrient management on lowland rice yield in Ghana

	Paddy Grain Yield (t ha^{-1})		
Treatment	Potrikrom	Biemso No.1	Biemso No.2
Control (no manure, no fertilizer)	1.68	2.59	1.50
$N-P_2O_5-K_2O$ (120-90-90) kg ha^{-1}	6.77	8.37	4.03
$N-P_2O_5-K_2O$ (90-60-60) kg ha^{-1}	6.57	7.09	3.90
Poultry Manure (7.0 t ha-1)	5.96	6.36	3.82
½ Poultry Manure + ½ Mineral fertilizer	6.25	7.30	4.15
Cattle Manure (7.0 t ha-1)	4.54	6.25	3.05
½ Poultry Manure + ½ Mineral fertilizer	4.86	6.49	3.72
LSD (0.05)	0.99	2.14	0.84
Mean (site)	5.23	6.09	3.58
LSD (site)		0.52	

Increase nutrient use efficiency is associated with improved water management. "Sawah" leads to not only significant improvements in nutrient use but also in water use as well. Under the "Sawah" system, Issaka et al, (2008) reported of significant increases in rice grain yield under improved soil and water management practices. Rice grain yield increased significantly in the order: farmers practice < bunded only < bunded and puddled < bunded, puddled and leveled (Table 4). Factors militating against soil fertility improvement include low fertilizer usage, ineffective fertilizer management under the traditional system, unfavorable land tenure systems, ineffective water management and lack of improved technologies. The "Sawah" technology (an eco-friendly technology) combines effectively with biotechnology (improved varieties) to improve and sustain rice yields under intensive land cultivation.

Both grain and stover yield increased significantly under "sawah" over the traditional system under farmer managed conditions. During its first year of introduction at most locations, grain yields increased over four-fold and continued to increase to over 6.0 t ha^{-1} currently across locations with different farmer groups (Tables 5 and 6).

Table 4: Effect of soil and water management on paddy grain yield in Ghana

Treatment/Variety	Bou. 189	Jam. 85	Sikamo	Wita 7	Mean
Year 1					
Farmers practice	3.9	3.8	3.2	3.3	3.6
Bunded alone	5.1	4.9	5.1	5.3	5.1
Bunded and puddled	6.8	5.5	6.5	6.2	6.3
Bunded, puddle and leveled	8.2	6.5	7.8	7.6	7.5
Mean	6.0	5.2	5.7	5.6	
Year 2					
Farmers practice	3.5	3.7	2.2	3.3	3.2
Bunded alone	4.2	4.0	3.2	4.5	4.0
Bunded and puddled	4.8	4.5	4.3	4.9	4.6
Bunded, puddle and levelled	6.2	5.5	5.6	5.4	5.7
Mean	4.7	4.4	3.8	4.5	
S. E. for each year			1.12		

Source: Issaka *et al*(2008).

Table 5: Comparison of yield (grain & stover) under improved system and traditional system

	Improved system				Traditional system	
	Jasmin 85		Sikamo		Lapers/Jasmine	
	Grain	Stover	Grain	Stover	Grain	Stover
Nsutem	5.4	13.8	6.7	16.5	2.6	14.6
Baniekrom	6.4	18.2	6.1	15.0	2.6	18.0
Mean	5.9	16.0	6.4	15.8	2.6	16.3

National mean yield for Ghana (2009) - 2.4 t ha^{-1}. source – Ministry of Food and Agriculture (MoFA)

Table 6: Mean grain yield of rice for farmer groups under "Sawah" from 2001-2009

Year/Group	Adugyama A	Adugyama B	Biemso A	Biemso B	Biemso C	Mean	Nat. Mean**
2001	4.0	4.4	4.8	4.7	-	4.5	-
2002	4.7	4.8	4.7	5.7	4.5	4.9	-
2003	3.8*	5.5	4.8	5.9	5.4	5.1	-
2004	5.0	5.5	5.5	6.5	5.5	5.6	-
2005	4.5	4.8*	-	5.4*	5.5	5.0	-
2006	5.6	5.7	-	-	5.8	5.7	-
2007	5.6	5.6	-	-	6.0	5.7	1.7 (6.5)
2008	5.8	6.0	-	-	6.2	6.0	2.3 (6.5)
2009	6.1	6.2	-	-	6.0	6.1	2.4 (6.5)

*Affected by floods; **source – MoFA, Ghana. Figures in parenthesis represent achievable yield

Figs. 1a, b, show the net profit accrued from rice cultivation under "sawah" for some farmer groups over a five year period. For each year, mean net profit per hectare was positive and this continued to increase with time. This is an indication of how profitable lowland rice cultivation can be particularly under improved technologies such as "Sawah". This will not only create employment for the rural youth but will more importantly and significantly reduce rural poverty and increase standard of living. "Sawah" was also observed to contribute positively to nutrient accumulation and retention particularly, the exchangeable cations. However, due to the very low levels of soil phosphorus and its enhanced uptake under reduced conditions in these valleys, particular attention should be paid to P additions and management.

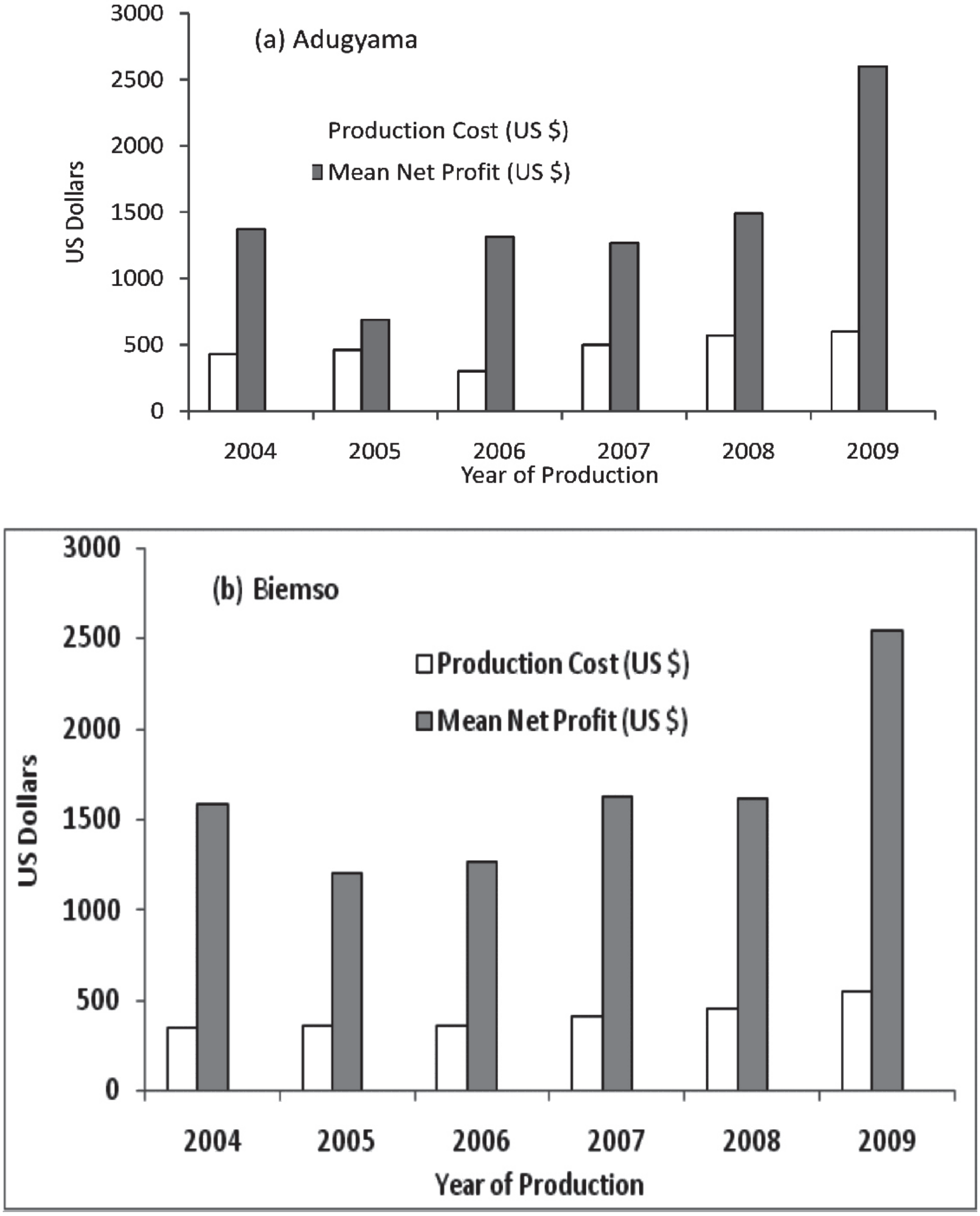

Fig. 1: Production cost and mean net revenue of selected farmer-groups from 2004-2009

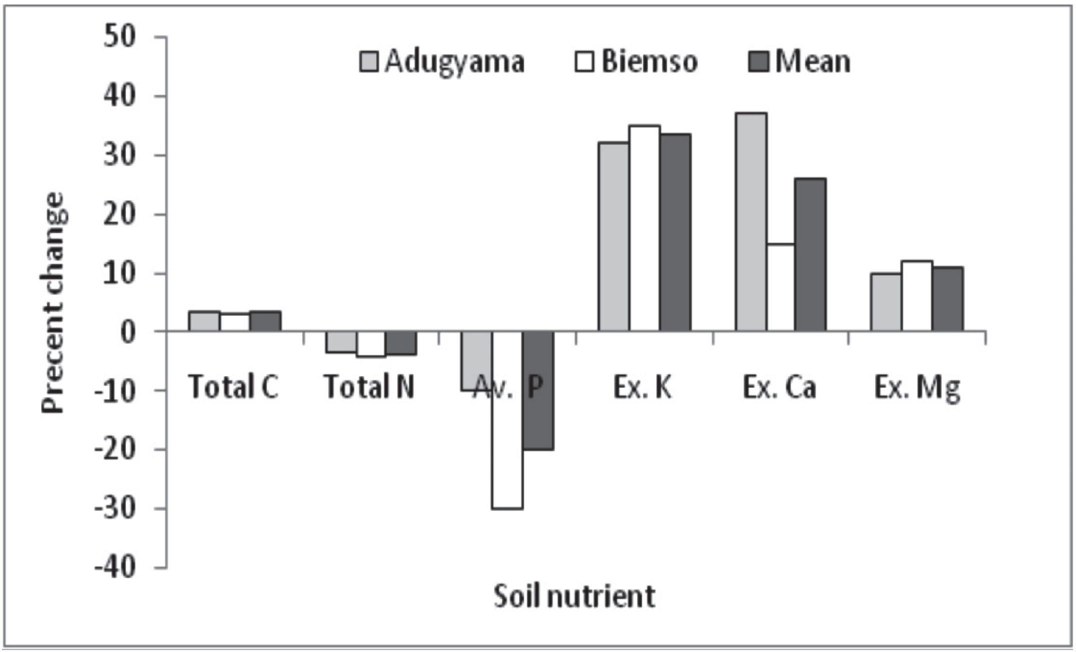

Fig. 2: Influence of sawah on nutrient accumulation in two valleys in Ghana from 2001 - 2008

CONCLUSION

To sustain rice cultivation in inland valley ecosystems in Ghana under current increased intensity, there is the need to out-scale eco-friendly technologies like the "sawah" system across the country. There is also the need to emphasize on integrated use of soil nutrient enhancement materials which are readily available for increased grain yields. For income generation, job creation and poverty reduction, the "Sawah" system of rice production can make a significant contribution.

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CHARACTERISTICS OF SELECTED ASH SOURCES AS QUICK MEANS OF RESTORING DEGRADED INLAND VALLEY SOILS AND RICE YIELD THROUGH SAWAH RICE FARMING IN EBONYI STATE OF SOUTHEASTERN NIGERIA

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ABSTRACT

In order to arrest the declining productivity of the inland valley soils in the study area, different ash materials and their mixtures (wood ash-WA, leaf ash-LA, rice husk ash-RHA, wood ash + leaf ash-WA +LA, wood ash + rice husk ash-WA +RHA, wood ash + leaf ash + rice husk ash-WA + LA + RHA and leaf ash + rice husk ash-LA + RHA) at 10 tons/ha were applied to the soil with effective sawah management system to evaluate their immediate effects on the productivity of the soil chemical properties and rice grain yield. Poultry droppings were applied at 10 tons/ha as basal application. The field layout was randomized complete block design (RCBD) in which the eight treatments (including the control) were replicated three times. The test crop was a high yielding rice variety (Oryza sativa var. FARO 52/WITA 4). Soil chemical properties tested were soil organic carbon, total nitrogen, pH, exchangeable bases (K^{+},Ca^{2+}, Mg^{2+}), CEC, EA, Base saturation (BS) and available phosphorous, while the grain yield of rice was also measured. Amendments were analyzed for pH, OC, N, Na, K, Ca, Mg, and P. The result indicated that all the soil exchangeable bases were highly significantly improved by the amendments in both first and second year of planting. The results also showed that soil pH, organic carbon and total nitrogen were statistically improved by the application of different ash sources during the period. The analytical results show that WA had high alkaline properties with a pH of 12.7, relatively higher than that of LA and RHA. Compared to WA and LA, RHA had a higher elemental phosphorous but a lower content of N, Na, K, Ca and Mg.

INTRODUCTION

Inland valleys, which have specific hydrological conditions and have been cited as having high potential for the development of rice-based small scale farming systems at village levels, occur abundantly in Nigeria and other West African sub-region in general (Moormann 1985; Wakatsuki et al.1998; Windmeijer and Andriese, 1993; and Nwite et al.; 2008). Maintenance of soil fertility, weed and water control are major constraints to utilization of these inland valleys for sustainable rice based cropping (Otoo and Asubonteng, 1995).

The African adaptive sawah lowland farming, with small scale irrigation scheme for integrated watershed management, will be the most promising strategy to increased and sustainable food production and at the same time restore degraded watersheds in tropical areas. The term 'sawah' refers to leveled rice field surrounded by bunds with inlets and outlets for irrigation and drainage. Sawah is the prerequisite for realizing the Green Revolution as well as preserving and even restoring ecological environment. Irrigation and drainage without sawah farming technologies has proven inefficient or even dangerous because of accelerating erosion (Hirose and Wakatsuki, 2002).

However, most soils in southern Nigeria and in parts of the humid tropics are acidic, due to nature of their parent material, high rainfall regime and intensity; and associated leaching of nutrients and weathering (Obi and Ekperigin, 2001). The low inherent fertility of most of the soils in Nigeria is responsible for poor crop yield. The soils have low pH, exchange capacity, are generally poorly buffered and poor in plant nutrient elements and rapidly loose their fertility on intensive cultivation (Balasubraman and Nnadi, 1980; Nwite et al., 2008). Ash generally has good acid neutralizing capacity and ability to supply the soil with bases (Ca^{2+}, K^{+}, P, Mg^{2+}, Na^{2+}); and this depends on the contents of oxides, hydroxides and carbonates of Ca, Mg, K and P. It has been stated that ash can be used to counteract natural and anthropogenic acidification of soil and loss of nutrients (Serafinelion, 2002; Eriksson, 1998),

Ash is a powder that remains after a material has burnt, such as wood, leaf and coal. Ash especially, wood ash reactivates arable soil of the physical, chemical and biological qualities that has been previously damaged as a result of inappropriate handling, unfavourable climatic condition as well as continuous cropping, over-usage of land and persistent use of N.P.K fertilizer. All these activities cause increase in soil acidity and degradation in soil physical and chemical properties, which lead to crop yield failure (; Abyhammar et al. 1994; Ojenniyi, 2002).

According to Martikainen (2002), an ash-induced pH increase of 0.6- 1.0 units of humus soil. may increase the decomposition rate of soil organic matter by soil microbes and thus speed up the rate of release of plant nutrients such as nitrogen (Serafinelion, 2002; Martikainen, 2002).

It was, also, found that burning rice husk and incorporating the ash into soil increases grain yield of rice and soil exchangeable calcium in sawah rice field in Nigeria (Nwite et al., 2008). Nwite et al. (2009) reported that essential plant nutrients such as exchangeable K and Ca, including fertility index as the CEC and available phosphorous, were statistically improved by the application of ashes (wood, leaf and rice husk ashes) in an Ultisol of Ishiagu.

The study aimed at ascertaining the characteristics of selected ash and, also, evaluating their influence on soil chemical properties and grain yield of rice in a sawah field of inland valley of southeastern Nigeria.

MATERIALS AND METHOD

SThe experiment was carried out on the flood plain of Ivo River in Ishiagu, Ebonyi State. The area lies within longitude 8^0 $3^/$ E and latitude 6^0 $25^/$ N. The annual rainfall and mean temperature is 1350 mm and 29^0 C, respectively. The area lies within the derived savanna vegetation zone of southeastern Nigeria, with grassland and shrub tree combinations. The period of dry season extends from November to March and the raining season falls between the months of April and October. The soil temperature regime is about 32.2^0 C (Nwite et al; 2008). Geologically, the area is underlain by sedimentary rocks derived from successive marine deposit of the cretaceous and tertiary period.

According to Lekwa et al.(1995) the location lies within the Asu River Group and consists olive brown sandy shale, fine grained micaeous sand stones and mud stones deposited in an alternating sequence. The soil is described as Aeric-Tropoaquent (USDA, 1998) or Gleyic Cambisol (FAO, 1988). They are sandy loam, with moderate soil organic carbon (OC) content on the topsoil, low in pH and cation exchange capacity (CEC). Soils are mainly used for rain-fed rice farming and vegetable production as the rain recedes.

Table 1: Some properties of the topsoil of the experimental plots (0 -20 cm) before tilling and amendment

Soil property	Value
Clay %	10
Silt %	21
Total sand %	69
Organic carbon % (OC)	1.61
Total nitrogen % (N)	0.09
pH (H_2O)	3.7
Exchangeable bases (cmolkg^{-1})	
Sodium (Na)	0.40
Potassium (K)	0.11
Calcium (Ca)	1.0
Magnesium (Mg)	1.56
Cation exchange capacity (CEC)	5.06
Exchangeable acidity (EA)	2.52
Available P (mg/kg)	4.30

The experiment was carried out in the 2008 and 2009 cropping seasons. The experimental design was Randomized Complete Block Design (RCBD). Eight levels of soil amendments (treatments), including the control were replicated three times. The soil amendments include different ash materials and their mixtures (i. wood ash-WA, ii. leaf ash-LA, iii. rice husk ash-RHA, iv. wood ash + leaf ash-WA +LA, v. wood ash + rice husk ash-WA +RHA, vi. wood ash + leaf ash + rice husk ash-WA + LA + RHA, vii. leaf ash + rice husk ash-LA + RHA and viii. Control-CT (no ash application)) at 10 tons/ha were applied to the soil.

The ash materials comprised partially burnt rice-miil wastes, saw-mill wastes and leaves of Acacia plant, collected respectively within the vicinity of the study site. Poultry dropping was used as basal application in all the plots at 10 t/ha, to supplement for nitrogen in the ash materials. The nutrient compositions (%) in the poultry dropping applied include: OC (16.52), N (2.10), Na (0.34), K (0.48), Ca (14.4), Mg (1.2), and P (2.55).

FIELD PREPARATION

The marked out site was cleared of vegetation and the initial soil sample was taken from the cleared portion to determine the initial soil characteristics. The marked area was bunded with a 0.6m raised bunds, ploughed, puddle and leveled with power tiller machine. The bunds with inlets and outlets drains were used to impound and control water throughout the growing period of the rice, in such a way that water is introduced into the field when needed and excess drain from the field. The poultry droppings were applied as basal, one week before transplanting, while the ash applications were done, two days before transplanting. Two weeks after transplanting, water from a spring source was introduced into the bunded and rice transplanted plots through a constructed canal. The quantity of water introduced into the plots was not measured, rather the depth of water was maintained at 5 cm – 10 cm throughout the growing period of the rice. The test crop used was a high yielding variety (Oryza sativa var. FARO 52/WITA 4).

The rice seedlings were transplanted at the age of three weeks after nursery and transplanting was carried out in rows, using a spacing of 20 cm x 20 cm with 2 seedlings per hole. On maturity, the rice was harvested, threshed and the grain yield weight was determined for each treatment. Another soil samples at 0-15 cm soil depth were collected at harvest, to assess the level of changes that occurred in the soil due to the treatment applications. Thereafter, data from the laboratory and field was again subjected to statistical analyses, using the procedure of analysis of variance (ANOVA) as described by Obi (2002).

LABORATORY METHODS

Soil samples were air-dried and sieved with a 2-mm sieve. Soil fractions less than 2 mm from each of the replicates were then analyzed using the following methods; Particle size distribution of less than 2 mm fine earth fractions was measured by the hydrometer method, as described by Gee and Bauder (1986). Soil pH was measured in a 1:2.5 soil:0.1 M KCl suspensions. The soil OC was determined by the Walkley and Black method described by Nelson and Sommers (1982). Exchangeable cations were determined by the method of Thomas (1982). CEC was determined by the method described by Rhoades (1982), while exchangeable acidity (EA) was measured using the method of McLean (1982). Available phosphorous was measured by the Bray II method (Bray and Kurtz 1945).

RESULTS AND DISCUSSIONS

Table 1 showed the chemical properties of the soil before the study. The soil was sandy loam in texture with pH of 3.7. The OC and TN (%) were 1.42 and 0.09 respectively. The exchangeable bases, Ca, Mg, K and Na were 1.0, 1.56, 0.8 and 0.4 $Cmolkg^{-1}$, respectively.

CHARACTERISTICS OF THE SELECTED ASH

The analytical results presented in Table 2 showed that wood ash (WA) had high alkaline properties with a pH of 12.7 and 15.6 $Cmolkg^{-1}$ of Ca, relatively higher than that of leaf ash (LA) and rice husk ash (RHA). Compared to WA and LA, RHA had a higher elemental phosphorous, but lower content of N, Na, K, Ca and Mg. LA had 5.0 $Cmolkg^{-1}$ Mg, and this was much higher than that of WA and RHA. A comparison of WA and LA shows that, except in C-organic content, both materials have relatively similar properties.

Table 2: Nutrient compositions (%) in the amendments

Property	*Amendment*		
	Rice husk ash (RHA)	*Wood ash (WA)*	*Leaf ash (LA)*
pH (H_2O)	6.9	12.7	10.4
OC	3.89	1.07	3.89
N	0.056	0.28	0.28
Na	0.33	0.33	0.45
K	0.65	3.08	1.77
Ca	1.0	15.6	10.4
Mg	1.4	3.6	5.0
P	11.94	4.98	1.94

SOIL PROPERTIES:

The effect of different sources of ash on soil chemical properties, pH (H_20), organic carbon (%), total nitrogen (%). The result in Table 3 showed that pH increased significantly ($P< 0.05$) with the application of different ash materials and their mixtures in the soil in both first and second year of planting. The result indicated that treatment 5 significantly improved the soil pH higher than other treatments in the second year, with the highest mean of 6.00; wood ash increased significantly higher in the first year with 5.2. The pH of the soil in all the amended plots, increased positively over the control. This increase in pH level could be attributed to the significant improvement in the exchangeable bases of the soil. This is in line with Markinkainen (2002) that an increase of 2 pH unit,leads to decrease in humus layer after ash was applied.

Table 3 shows the effect of different sources of ash on the organic carbon percent of the studied soil. The result indicated that there was statistical difference among the treatment at 5% level ($p \leq 0.05$). It also indicated that treatment 3 (RHA) significantly ($P < 0.05$) improved OC higher than other treatments in both first and second year of the study and also, all the treatments significantly increased OC over the control plots in both years.

The result shows that soil nitrogen was statistical ($P < 0.05$) affected by the treatments. The result indicated that treatment 7 recorded the highest mean of 0.113, followed by treatment 4, with 0.099 in the second year, while WA had the highest value in the first year.

However, there was reduction in total nitrogen of the soil in some treated plots below the initial soil total nitrogen in both years. This agrees with Ayeni (2010) that the overall magnitude in the enhancement of N by ash amendment in the treated plots, suggests N volatilization during burning process and high level of top soil N volatilization and denitrification. The result is also in line with the reports of Saarsalmi et al., (2001) and Arvidson and Lundkvist (2003). This reduction could be related to the fact that in flooded condition, after oxygen is consumed, virtually all the nitrate present in the soil are denitrified and lost to the atmosphere (Nwite et al. 2008b).

Table 3: Effect of different sources of ash on pH, organic carbon and total nitrogen.

Treatment	pH (H_20)	Organic carbon (%)	Total nitrogen (%)
First year			
WA	5.2	0.76	0.065
LA	5.1	0.86	0.056
RHA	4.9	1.07	0.056
WA+LA	5.0	0.65	0.047
WA+RHA	4.9	0.87	0.065
WA+LA+RHA	4.9	0.91	0.056
LA+RHA	4.8	0.92	0.057
CT	4.0	0.54	0.043
Mean	4.9	0.82	0.056
LSD (0.05)	0.22	0.22	0.006
Second year			
WA	5.7	0.95	0.070
LA	5.3	2.15	0.058
RHA	5.3	1.12	0.067
WA+LA	5.9	0.53	0.099
WA+RHA	6.0	0.85	0.071
WA+LA+RHA	5.0	1.50	0.089
LA+RHA	5.3	1.6	0.113
CT	2.6	0.07	0.026
Mean	5.1	1.10	0.074
LSD (0.05)	0.14	0.17	0.007

EFFECT OF DIFFERENT SOURCES OF ASH ON EXCHANGEABLE BASES (CA, K, MG,)

Table 4 shows that Exchangeable bases (Ca^{2+}, K^{+},Mg^{2+}) were statistical ($P< 0.05$) improved by the application of the treatments in both years except Mg, which did not show a significant difference in the first year of study. The significant improvement in the exchangeable bases could be as a result of the release of the organic forms of these elements in these ashes and their mixtures. Also, the residue ashes specifically had liming effect on the soil, owing to the higher levels of Ca, K, and Mg detected on the ash materials. It also showed that in the second year, the values for exchangeable Mg varied significantly. It changed from1.13 cmol/kg in the control plot to 2.83 in the LA+RHA treated plots (Table 4). These results are in line with the report of Ayeni (2010) in an experiment carried out in two locations with cocoa pod ash that the values of Ca and Mg increased with increased levels of the ash. With this, he stated that it confirmed the positive effect of ash on cationic nutrients.

Table4: Effect of different sources of ash on exchangeable bases. (Ca^{2+},K^{+},Mg^{2+})cmolkg[1]

Treatment	Ca^{2+}	K^{+}	Mg^{2+}
First year			
WA	2.53	0.22	1.20
LA	2.20	0.21	2.20
RHA	1.87	0.13	0.87
WA+LA	2.13	0.14	1.27
WA+RHA	1.93	0.12	1.13
WA+LA+RHA	2.00	0.17	1.20
LA+RHA	1.73	0.18	0.93
CT	1.47	0.07	0.73
Mean	1.98	0.16	1.19
LSD (0.05)	0.36	0.02	NS
Second year			
WA	4.00	0.30	2.81
LA	3.22	0.21	1.23
RHA	2.47	0.17	2.03
WA+LA	4.03	0.20	1.60
WA+RHA	3.63	0.16	2.40
WA+LA+RHA	3.27	0.20	2.00
LA+RHA	2.97	0.16	2.83
CT	1.01	0.10	1.13
Mean	3.08	0.19	2.00
LSD (0.05)	0.271	0.04	0.26

EFFECT OF DIFFERENT SOURCES OF ASH ON CEC, EA, AND BS

The result in Table 5 shows that CEC was highly improved significantly ($P< 0.05$) by the application of ash in the two years of planting, with leaf ash performing best.

The result indicated that the exchangeable acidity was statistically ($P< 0.05$) increased in the control plot (2.65 and 2.87cmolkg[1]) more than the treated plots in the second and first year of study respectively.

Apart from the fact that EA differed significantly ($P< 0.05$) in both years with amendments, it was also noticed that EA value trend was generally decreased in the second year of planting. The low magnitude in the overall mean values was considered to be a nice attribute for the sawah system.

However, a line of trend of the results showed that the percent base saturation and CEC increased significantly ($P< 0.05$) higher in the second year of planting. This, thus further confirmed the superiority of the sawah management. This agrees with the reports of Nwite et al., (2008 a and b) on an experiment performed to evaluate the effect of sawah on soil properties, that sawah management is confirmed to be superior over non-sawah management in the generation, release and reserve of soil plant available nutrients. Similarly, the superiority of sawah over non- sawah for a profitable rice production in terms of nutrient reserve, has earlier been highlighted (Wakatsuki et al., 2002; Ganawa et al., 2003; Wakatsuki and Masunaga, 2005).

Table 5:Effect of different sources of ash on CEC, EA and BS.

Treatment	CEC ($cmolkg^{1}$)	EA ($cmolkg^{1}$)	Bs (%)
First year			
WA	3.72	1.73	50.5
LA	4.06	1.70	56.8
RHA	3.26	1.87	52.5
WA+LA	5.87	1.87	50.7
WA+RHA	3.71	1.18	48.6
WA+LA+RHA	5.56	1.93	53.3
LA+RHA	4.03	1.97	49.7
CT	2.79	2.87	37.7
Mean	4.13	1.89	50.0
LSD (0.05)	0.96	0.80	7.4
Second year			
WA	7.75	1.26	84.60
LA	9.10	2.17	81.59
RHA	6.3	1.62	82.71
WA+LA	6.6	1.75	72.56
WA+RHA	7.7	1.14	70.45
WA+LA+RHA	8.5	1.88	71.53
LA+RHA	8.01	1.44	77.43
CT	3.95	2.65	38.64
LSD (0.05)	1.0	0.27	2.385

EFFECT OF DIFFERENT SOURCES OF ASH ON GRAIN YIELD OF RICE

Table 5 presents the effects of different ash materials and their mixtures on the grain yield of rice. Generally, there were significant ($P < 0.05$) improvements in rice yield in the amendments over the non-amended (CT) plots. In the first year of planting, the rice grain yield increased significantly ($P < 0.05$) from 1.80 tons/ha in the control plots to 6.50 tons/ha in the leaf ash treated plots. Also, in the second year of planting, yield increased significantly from 2.1 tons/ha in the CT plots to 6.80 tons/ha in the leaf ash treated plots. It was also shown that the crop responded differently to the soil amendments. However, the underlying factor was that, in the second year of planting, more grain yield was obtained in both amended plots and un-amended plots compared, to the yield of the first year of study. This agrees with Ofori et al., (2005) that high yield of rice responded to good water management condition in the sawah system with optimum input level. The results for the two years of study also confirmed the report of Nwite et al., (2010) that the high improvement in the grain yield of rice could be attributed to the fact that ash has more ability to buffer the soil and this may initiate the release of available plant nutrients in the soil.

Table 5: Effect of different sources of ash on the grain yield of rice (t/ha)

Treatment	**Mean yield (t/ha)**	
	First year	Second year
WA	6.37	6.65
LA	6.50	6.80
RHA	5.26	6.15
WA+LA	5.45	6.07
WA+RHA	6.44	5.55
WA+LA+RHA	5.31	5.41
LA+RHA	5.37	6.13
CT	1.8	2.1
Mean	5.31	5.61
LSD (0.05)	0.32	0.80

CONCLUSION

From the present study, the following conclusions can be drawn. The soils are low in pH and poor in plant nutrient elements. In spite of that, the ash materials were able to improve the pH of the soil by raising the pH in the first and second year of planting. Generally, essential plant nutrients such as exchangeable Ca, K and Mg including the fertility index like CEC were improved upon in the ash amendments and sawah management within the period. The organic carbon and total nitrogen were statistically improved by the application of different ash sources. The rice yield performance was positively and statistically increased by the soil amendments and sawah management in both first and second year of study, with leaf ash giving the highest significant increase in the yield.

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Landlord-Tenant Relationship and Land conflict Management: A case study of Sawah-based Rice production System in Nigeria

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ABSTRACT

This study examines the effect of land conflicts and landlords-tenants relationship on sawah Ecotechnology system of rice production in Nigeria. The study was carried out in six states- Niger, Kaduna, Ondo, Kwara, Abuja and Ebonyi, where sawah rice technology is being practiced. A total of 124 sawah farmers were selected, based on their participation in sawah-based rice production. All the farmers occupy the lowland area and adopt bunding in their land preparation for sawah rice. Land tenure system on the lowland is mainly permanent through inheritance and temporary through rental. Farm size ranged from 0.03-10 hectares, and average yield was 4.65 tonnes, indicating high productivity. Tenants pay ?12,000/ha on land-for-cash agreement and 5% of total yield of rice on land-for-rice agreement. The major causes of land conflict are scarcity of lowland and lack of proper demarcation. The unwritten agreement is binding and honoured by both parties and serves as basis for resolving conflicts. Regression Analysis (RA) shows that there is a significant relationship between yield of farmers and land tenure ($\beta = 0.61$, $p < 0.01$), sawah method adopted by farmers ($\beta = 0.24$, $p < 0.01$), access to farm resources ($\beta = 0.11$, $p < 0.05$), years of experience in rice production ($\beta = 0.24$, $p < 0.01$), farm size ($\beta=0.33$, $p < 0.01$) and years of experience on sawah technology ($\beta = 0.19$, $p < 0.01$). The findings of the study indicate that land tenure system affects sawah development and hence a need to address land tenure issue for a sustainable sawah rice production in Nigeria.

INTRODUCTION

The role of land tenure in agricultural development has been a subject of intensive research, particularly within the context of land and agrarian reform. Since all agricultural systems depend on land, the ownership of, or access to agricultural land becomes crucial in the consideration of factors which determine agricultural land-use systems.

Land is a finite, non-reproduceable consumption resource held as a source of livelihood and financial security, transferred as wealth across generations (Ellis, 1992). People's standard of living, wealth, social status and aspirations are all closely linked to land (Niroula and Thapa, 2005) and is the pivot of man's absolute existence (Oyekale, 2007). The land tenure system affects agricultural land use and prospects for improvement (Atteh, 1985). Access to land is based on membership of a land holding community by birth.

Many farmers depend on leased or rented farmland to have a business of adequate size and income. This makes long-term positive relationships with landlords one of the keys to their success. Good production management and marketing do not overcome insensitivity to landlords' values, objectives and frustrations. On the other hand, many landlords depend on their lease income for financial security. They also seek stable and hassle-free relations with their tenants. Agricultural land rental may take the form of cash rent or crop-share, depending on the situation. In case of cash, the tenant makes cash payment for the use of land and in case of crop-share the landlord receives a share of the crops, depending on the arrangement. Relationships are an important and often under-appreciated source of risk to tenant farmers and their landlords. For the landowner, an effective relationship management strategy helps ensure that her investment goals for the farmland are reached. For the tenant, it is fundamentally important to his security of tenure. For both parties, it prevents or mitigates the “costs” of conflict and disagreement (Ohio State University, 2010).

Attempts to overcome tension that sometimes arise when relationship between landlord and tenant gets sour, had made government of different countries to initiate land reform's programmes. Land reform programmes bring about changes in social power balances, rules and norms, as well as institutional structures; and, as such, they tend to provide regulation to some societies on the arrangement for the use of land but sometimes creating some sources of problems for others.

The land tenure system in Nigeria was changed by proclaiming a Land Use Decree (Act) in 1978, which purports to take over the administration and control of land in the country (Fabiyi, 1984). Land Use Decree of 1978, considered it in the public interest, that the rights of all Nigerians to land in Nigeria, be asserted and preserved by law. It is important to embark on land reform to ensure equitable access to productive opportunities on the land and security of such access.

Also to reduce a situation of wide scale speculative purchases of large tracts of (communal) land, in the absence of land taxes, mostly done by wealthy non-farmers who held the land idle, waiting to capitalize on an appropriate market situation, while food production is on the decline (Fabiyi, 1984). The objectives of the decree are to facilitate rapid economic and social transformation of the country through a rationalization of land use, to enable state governments bring about proper control and administration of land for the benefit of their people, to curb the incidence of rising land prices arising from activities of speculators particularly in urban areas, to remove a main cause of social and economic inequality and to provide an incentive to development by providing easy access to land for the state and the people. The objectives of the land use act have remained largely unfulfilled several years after its enactment and title to land appears to be more insecure now than it ever was. The position today is that land is less available to the ordinary Nigerian as it was during the pre-land use Act, thus holding most of the citizens to inevitable state of perpetual tenants. Land administration in Nigeria now rest on communities, transferred from one generation to another as the family inheritance.

The right to use land for long periods of time encourages the use of land-saving investments and land tenure affects agricultural production decisions. Land tenure is one of the major problems facing agricultural development (Li, 1998). The availability of land, accessibility, fertility and more importantly, suitability of the land, remain important constrain affecting agricultural development. Thus, the role of landlord-tenant relationship cannot be overemphasized for effective adoption and utilization of any technology. For sawah technology of rice production to succeed and to realize green revolution in sub-saharan Africa, and Nigeria in particular, addressing land owner and tenant relationship is essential. The improvement of rice growing environment through the promotion of lowland sawah eco-technology will be a mirage if land tenure as it relates to landlord-tenant relationship is not addressed.

This necessitated the need to carry out a study to examine the landlord-tenant relationship, land conflict and conflict management strategies in Nigeria, with a view to improve the adoption of sawah rice production technology. This study examined the relationship between landlords and tenants and its effect on sawah technology development in the country. The specific objectives are to examine the land tenure system in sawah production area in Nigeria, identify the conditions of land rental in the study area, identify the constraint faced by sawah farmers in accessing land and examine the nature of land conflict among tenants and land owners.

SAWAH RICE PRODUCTION IN NIGERIA

Sawah rice production system was introduced to the inland valley of Nigeria because it can overcome soil fertility problems through enhancing the geological fertilization process, conserving water resources and high performance multi-functionality of the sawah type wetlands (Oladele and Wakatsuki, 2008). Sawah refers to leveled rice field surrounded by banks with inlet and outlet for irrigation and drainage. The basic elements of sawah system include improved irrigated rice basins, seedbed preparation, transplanting and spacing of seedlings, fertilizer application and most importantly, appropriate water management. Fashola(2006) noted that the sawah system offers the best option for overcoming the constraints of rice production in Nigeria, namely poor soil fertility, poor water management and poor varieties. It is because the sawah system utilizes the inland valleys, which are reported to be high in fertility and through appropriate water management, fertility can be sustained and enhanced for rice production. The goal of sawah rice production is the development of sustainable production systems of the whole watershed, which allows intensification and diversification of the lowland production system and stabilizing improved production systems on the upland. Lowland ecosystem has a relatively high potential for expansion: it occupies an estimated 20 million to 50 million hectares in West Africa (WARDA, 1998). In addition, considering the gap between potential and actual yields (1.4t/ha vs. 2.5–5.0t/ha, according to WARDA, 1999), it is reasonable to argue that rice production in rainfed lowland has a high potential for intensification, which would facilitate meeting the growing demand for rice in Nigeria and even in West Africa.

MATERIALS AND METHODS

The study was carried out in Nigeria. The country is located in West Africa and shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east and Niger in the north. Its coast in the south lies on the Gulf of Guinea on the Atlantic Ocean. Nigeria has a total area of 923,768 km^2 (356,669 sq mi.). Nigeria has a varied landscape; the far south is defined by its tropical rainforest climate, where annual rainfall is 60 to 80 inches (1,524 to 2,032 mm) a year. Approximately 70 percent of the population engages in agricultural production at a subsistence level. Agricultural holdings are generally small and scattered. Nigeria has 36 states, including its Federal Capital city, Abuja.

This study was carried out in states where sawah is being practiced. These states are: Niger, Kaduna, Ondo, Kwara, Abuja, and Ebonyin. Data used in this study were collected in all the sawah sites in Nigeria namely: Bida, Zaria, Ilorin, Abakaliki, Abuja and Akure. A well structured interview guide wasused to elicit information from the farmers. A list of rice farmers in the villages where sawah technology was disseminated was compiled. The availability of inland valley is a prerequisite for the adoption of sawah rice production technology. One hundred and twenty four farmers in the study locations were interviewed in the course of the research. These are farmers practicing the newly disseminated technology. The farmers are spread across these geographical locations of Nigeria, with the bulk from Niger state, since sawah was first introduced in Bida in 2002. Descriptive statistics was used to analyze the socio-economic and farming characteristics of the farmers, while regression analysis was used to determine the relationship between other study variables. The variables employed in the study and measurements are shown in Table 1.

RESULTS AND DISCUSSION

Socio-economic and farming characteristics of the respondents: Table 1 shows the socio-economic and farm characteristics of the respondents. The result of the study shows that majority (98.90%) of the respondents are male. The mean age of the respondents was 42.30. The data revealed that the bulk of the farmers (65.40%) fell within the productive age of 15-45 years and few aged farmers are involved in sawah farming. Majorities (98.80%) of the respondents are married and have Quranic education (62.70%) and are Nupes (73.40%). This agrees with the findings of Fu et al (2009) and Oladele and Wakatsuki (2009). Household size of the farmers ranged between 1 and 40, with a mean of 14. 55% of the farmers have family size of between 11 and 20. This relatively large size of the household will serve as source of labour that can be used on the farm.

The mean size of farms grown on sawah is 0.5ha, however, majority of the farmers have farm sizes of less than 0.5 ha, with mean income of ₦151,000.00 Mean farmers' years of experience in rice production and sawah production are 32 and 6 years, respectively. This implies that the respondent have gathered enough experience in rice production and hence, are capable of using sawah technology. Also, their experience in rice production will be of great importance in developing the skills required for sawah rice production. The mean yield of rice from the sawah field is 2.5tonnes, with majority of the farmers (77.30%) having yield of less than 2 tonnes. The yield corresponds with the size of the field. Yield of sawah field among the sawah farmers was 4.65 t/ha. Lowland rice farming is predominantly practiced by the farmers and they only bund their field.

Table 1. Socio-economic characteristics of the respondents (N = 124)

Attributes	Measurement	Distribution
Sex	Nominal	Predominantly Male
Age	Continuous	Average age =42.3
Educational level	Nominal	Predominantly Quranic
Ethnicity	Nominal	Predominantly Nupe
Household size	Continuous	Average=14 persons
Yield	continuous	Average = 2.5tonnes
Farm size	Continuous	Average=0.53ha
Income	continuous	Average=?151110
Years of experience in rice production	Continuous	Average=32 years
Years of experience in sawah rice production	Continuous	Average=6 years
Type of land used	Nominal	Predominantly Lowland
Sawah type	Nominal	Predominantly Bunding

Land tenure system: As shown in Table 2, the land tenure system among the farmers is prodominanly by inheritance. This result agrees with the findings of Fu, et al, (2009) and Oladele and Wakatsuki, (2009). However a low proportion of the farmers got their land used for sawah by rentals and in turn pays ?12,000 on every hectare of land used in a year and in some situations, farmers give 5% of their yield to the land owners as rent. Special cases occur where tenant pays cash as rent before the use of land and also give part of their yield to the land owners after harvest. Releasing of land to tenants by land owners is based predominantly on ethnicity. Land owners prefer to give land to farmers from the same ethnic inclination but some time to farmers from another ethnic group, based on their social relationship and social status.

Table 2: Land tenure systems in the study area (N = 124)

Variable	Measurement/Definition	Percentage
Land tenure	a. Own	10.10
	b. Rentals	16.00
	c. Inheritance	72.30
	d. Gift	1.60
Factors influencing land acquisition	Ethnicity	82.40
	Social Relation	63.90
	Social Status	15.10
	Financial factors	0.80

Land right and rental in the study area: Land right in the study area is basically, communal land right regime. In this type of regime, there exists use right, control right and transfer right. Both land owners and tenants have the right to use land for growing sawah rice. However the use right of the land owner is without restrictions, in which the landlord can plant any type of crop and erect any structure on the land. The reverse is the case for tenants. Tenants are only allowed to use the land for rice production and in some cases other arable crops. Tenants are restricted from leaving the land to fallow and are not allowed to grow permanent crops on the land. There is also a limit to how the tenant can use the land for grazing of their small ruminants after harvesting their rice. The short period of tenancy, sometimes restrict tenants from constructing structures that are needed during the layout of the sawah plot.

Control right on the land rests solely on the land owners. They decide the size of land to be cultivated by tenants and may hinder the tenants from expanding the size of their sawah farms in a situation in which the land owners wish to expand the size of their farms. The transfer right on land (from one person or generation to another) rests solely on the land owners. A tenant is not allowed to give the land he is using to another tenant in case he is not ready to use it for sawah production. In addition, land owner can only give a portion/parcel of his land to a tenant, after due consultation with the family head and other members.

Use of land among tenants is not secured. The land owner may decide to take over his land at anytime he so desires. However, this is one of the major factors affecting the expansion of sawah in Nigeria. Sawah rice can be grown on land with high water content, from the planting stage through harvest. Structures, such as bunds and canals are also constructed on sawah fields. Only the land owners have security on land. Land use decision rest solely on the land owners. The decisions sometime, if not in line with the plan of the tenants, could not be challenged. However, land owners take decisions in consultation with other family members.

Since the introduction of sawah eco-technology method for rice production and the drastic change in the yield of farmers, the method of accessing land for sawah has been more competitive among farmers. Land owners now give upland to tenants more easily and in larger sizes than lowland on which sawah is being cultivated. This is with the aim of having enough land for the expansion of his sawah farm size. In other words, tenants find it more difficult to access lowland as against upland. This problem is bound to persist even more in the nearer future, if the issue of land tenancy is not addressed.

Two main rental arrangements were identified in the study area: land-for-paddy and land-cash-rent. Rent paid on the use of land is predominantly by paddy (83.33%), as land-for-paddy agreement. Farmers give 5% of the total yield harvested from land rented to the land owner as land-for-rice agreement. However, those who pay cash on land, paid ?12,000 on each hectare of land used per annum. The rent is however fixed in advance and it is based on verbal agreement between the land owner and the tenant. This nature of agreement is however believed to be fair to both parties. The duration of the agreement ranges from 2-15 years. Land owners deserve the right to take over the land from the tenant as part of the agreement in a situation of refusal of the tenant to pay rent, subletting of land to other tenants, failure to renew agreement on expiration, non observance of the local customs and social abuse in the community.

Table 3: Land Right in the Study Area (N = 124)

Right	*Landlord	*Tenant Farmer
Right to use	Yes without limitations	Yes with limitations
Right to control	Yes without limitations	No right to control
Right to transfer	Yes with consultation with family members	Now right to transfer.
Security of land	Secured	Not secured

*** All landlords (79) have same right and all tenants (45) have same right**

Land related constraints: The major constraints faced by farmers in accessing land for sawah production are accessibility of land, availability, short duration of the tenancy period, acquisition of land and interference from other farmers. Farmers go as far as 15km from their houses in search of suitable site for sawah development due to the nature of land ownership in the study area. It is based on this, that Oladele and Wakatsuki (2010) suggested that there is a need to address constrains faced by the continued waste of time and energy dissipated trekking long distances before getting to the field and make less time available for farm work. Most roads leading to farmers' fields are in deplorable condition, making transport of input and yield in and out of their farms a difficult task. The period of tenancy and interference from landlords sometimes create problems to tenant farmers on the use of rented lands. Due to increase in yield from sawah rice fields as compared to the traditional methods (from 1.5 tons per hectare (WARDA, 1999) to 4.65 tons per hectare based on the result of this study), most landlords have resulted to either increase the rent on their land, which has considerable effect on the tenant, or refused to renew the tenancy period (Oladele and Wakatsuki, 2010).

Table 4: Land related constraints and severity of the constraints (N = 124)

Constraints	Very severe (%)	Severe (%)	Not severe (%)	Mean	Std deviation
Accessibility	40(31.90)	25(20.20)	59(47.90)	1.84	0.88
Availability	26(21.00)	25(20.20)	73(58.80)	1.62	0.81
Dispute and conflict	0(0.00)	0(0.00)	124(100.0)	1.00	0.00
Tenancy payment	0(0.00)	0(0.00)	124(100.0)	1.00	0.00
Longevity of use	0(0.00)	8(6.70)	116(93.30)	1.07	0.25
Interference	10(8.40)	0(0.00)	114(91.60)	1.16	0.56
Government policies	0(0.00)	1(0.80)	123(99.20)	1.00	0.09
Acquisition	34(27.70)	17(13.40)	73(58.80)	1.69	0.88

LAND CONFLICT, CAUSES AND RESOLUTION METHODS IN SAWAH SITES IN NIGERIA

A qualitative survey was carried out in sawah site affected by land conflict. A case study of the nature, causes and the resolution methods adopted and being adopted are discussed in this study.

Ilota and Idofian are two communities in Kwara state, Nigeria. They share common boundary with a large expanse of lowland. A parcel of land given to a tenant by a land owner from Idofian prepared for cultivation for sawah in 2008 cropping season led to an inter-communal conflict and was latter left uncultivated for two consecutive seasons, 2008 and 2009. The main cause of the conflict was on an uncleared boundary demarcation and identity claim by both communities. The two communities claimed ownership and control of the land. Attempt to settle the conflict in the early stage yielded no result. The intervention of the Ilorin sawah team, with the assistance of the village extension agents of the agricultural development project, sought the audience of sawah contact farmers in the two warring communities, the traditional rulers in the communities and the conflict was resolved amicably. The tenant farmers now use the land for sawah.

A similar type of conflict occurred in Ejeti, a community in Bida, Niger state. It was between two communities claiming ownership and control over land. It was caused by lack of proper demarcation and conflict among groups using the land in the two communities. This led to court litigation and is yet to be resolved. However, a different nature of conflict occurred between land owners and tenants in Wako site of the Federal Capital Territory in Abuja.

Farmers using the land pay rent to the land owners, who sublet the land in accordance with the local custom and arrangement of the community, but later decided to take over the land, because of the introduction of the sawah technology to the farmers, which led to increase in the yield of rice for the tenant farmers. The tenants' refusal to release the land, since the tenure of rent has not expired,thus leading to conflict of interest among the two parties. However, the intervention of the community leader and the sawah contact farmer, assisted in resolving the conflict.

Regression analysis between study variables: Table 5 shows the results of regression analysis between yield of sawah rice and predictors. Land tenure was related to yield of sawah rice ($\beta = 0.61$, $p < 0.01$). This implies that land tenure system has a significant effect on the yield of farmers. When there is a feeling of insecurity of tenure, a farmer will be less likely to invest in long-term improvements inthe land that may be costly in terms of capital, time and labour (Adedipe et al., 1997). Sawah technology involves the construction of structures such as bunds, canals, irrigation drainages and dykes that will stay for long period of time or permanently. Thus, insecurity of land may not encourage farmers to construct such structures and this will have negative implication on yield from sawah field. Sawah method adopted ($\beta = 0.24$, $p < 0.01$) by farmers is significantly related to yield. A standard sawah will start from proper field layout, through bund construction, puddling, leveling and smoothening (Wakatsuki, 2008). Absence of any of the stages of sawah development will have a significant negative effect on the yield.

Access to farm resources ($\beta = 0.11$, $p < 0.05$) is significantly related to the yield of sawah rice. Available resources such as farm inputs, labour and machinery will determine the yield of farmers. Other variables such as years of experience in rice production ($\beta = 0.24$, $p < 0.01$), farm size ($\beta = 0.33$, $p < 0.01$) and years of experience on sawah technology ($\beta = 0.19$, $p < 0.01$) affect the yield of farmers. This implies that, increase in the number of years of experience, increase in the size of farmers' field and increase in the years of experience practising sawah, will influence the yield of the sawah farmers.

Table 5: Regression analysis showing relationship between yield and predictor variables (N = 124)

Variables	Std β	t-ratio	Prob
Constant	-	2.49	0.01
Age	0.45	0.58	0.55
Educational level	0.06	0.97	0.33
Farm size	0.33	0.43	0.66
Sawah type	0.24	3.94	0.01
Income	0.04	0.70	0.48
Household size	0.09	1.29	0.19
Access to resources	0.11	1.96	0.05
Years of experience in Sawah	0.19	3.02	0.01
Land tenure arrangement	0.61	10.07	0.01
Years of experience in rice production	0.24	1.98	0.05

R = 0.82, R^2 = 0.68, Adjusted R^2 = 0.64, F = 18.72.

CONCLUSION AND RECOMMENDATIONS

The result of the study concluded that land tenure influences substantially on the adoption of sawah technology in Nigeria. The adoption of sawah technology is higher on the side of the landlord farmers, since they have access to and control over the use of land. Yield and size of farmers with secured tenancy is considerably higher than those without security of land. The result also shows that land conflicts have negative impact on the adoption and dissemination of sawah technology.Farmers need to make concrete arrangement with land owners before embarking on sawah development. The study recommends that,sustaining and improving sawah rice production in the study area will require addressing land tenure issue of both landlords and the tenants. It also recommends that an effective communication mechanism should be established between both landlords and the tenants.

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QUALITATIVE ANALYSIS OF RICE STORAGE SYSTEM IN YALA LOCAL GOVERNMENT AREA OF CROSS RIVER STATE

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Abstract: This study examines the rice storage system in Yala L.GA of Cross River State. One hundred and twenty structured questionnaires were used for the study. It was administered to rice storage farmers across five major communities in the local government (Ikoko-mfuma, Mbura, Wanudu, Ntrigom and Ijokom). Data was analyzed using a descriptive statistic and regression analysis to determine the activities of the rice storage farmers. The study revealed that a greater percentage of 55.0% of married men were involved in rice storage. The male constitute a percentage of 24.2%. It was also revealed that 20.5% has primary education, 43.2% has secondary education and 5.2% has Tertiary education. 31.1% has no formal education. The study also revealed that 36.6% of the farmers use ware house to store their rice, 49.2% used hermetic storage, while 14.2% use the silo system. The result of the regression analysis shows that gross return on storage (t = 4.130) is significant at 0.05 probability level.

INTRODUCTION

Rice is cereal crop that helps sustain twoy–third of the world population. Although, rice is cultivated world wide, it originated and distributed through tropical and sub tropical region of Africa, Asia central and South America and Australia. It is a leading cereal crop and main food in Nigeria. It also found use as both a ceremonial and staple food (Taylor, 1996).

There are about 25 species of rice but two are the major cultivated ones. It is planted on both upland and wet land (swamp). The culinary quality of rice depends on largely on its variety and length of time it is kept in storage. Coons et al. (2004) found that rice (paddy) remain in good condition for a considerable period. Storage of milled rice for long period should however be avoided. Under-milled rice has a short storage life span, owing to its high fat content, which develop rancidity and unpleasant odor and taste. Unless it is thoroughly dry, parboiled rice is liable to become discoloured on storage (Coons et al.,2004). The main causes of losses in storage are attributed to metabolism of grain tissues, micro organisms, insect and mites.

MATERIALS AND METHOD

The study was carried out in 5 communities in Tab Local Government Area of Cross River state. The communities includes: Ikoko- mfumo, Mbuora, Wonudu Ntrigon and Ijokom. These communities are known for rice production in the state. A total of 120 respondents were randomly sampled and administered questionnaires. Descriptive statistics and regression analysis were used in the analysis.

The regression equation was used to estimate the gross returns and the cost of operation. The first functional relationship is of the quadratic equation of the two inputs, which represents their cost equation.

$C = a + b_1 X_1 \ x \ b_2x_2 - b_3 x_2^2 + b_5 x_1x_2$

Where C = Cost of operation.

X_1 = Quantity stored in kg

X_2 = Inventory period in weeks

The second functional relationship is of the form

$Y = b_0 + b_1x_1 + b_2x_2$

Y = Gross returns in Naira

X_1 = Quantity stored in kg

X_2 - Inventory period in weeks

Table 1 shows the gender (male and female) distribution. The results revealed that the male respondents constitute a higher percentage of 81.25% and the female constitutes less (18.75%). This result implies that the male are much more involved in rice storage activities than their female counterparts.

RESULTS AND DISCUSSION

Table 1: Distribution of Respondents Across Gender (N=112)

Gender	Frequency	Percentage (%)
Male	91	81.25
Female	21	18.75
Total	112	100.00

Source: Field Survey (2010).

Table 2:Distribution of Respondents According to Level of Education

Level of Education	Frequency	Percentage (%)
Primary Education	24.6	20.5
Secondary Education	51.9	43.2
Tertiary Education	6.2	5.2
None	37.3	31.1
Total	120	100.0

Source: Field Survey (2010).

Data in table 2 reveals that 20.5% of the respondents undergo primary education, 43.2% had secondary education, 5.2% had tertiary education, while 31.1% had no former education. This invariably suggests that a significant number of the respondents have some form of formal education to understand the benefits of storage.

Table 3:Marital Status of the Respondent

Marital Status	Frequency	Percentage
Single	54	45.0
Married	66	55.0
Total	100	100.0

Source: Field Survey (2010).

Table 3 shows the representation of the marital status of respondents. 55.0% of the respondents were married, while 45.0% were single. These results indicate that married men and women are much more involved in rice storage business than the singles.

Table 4: Distribution of Respondents According to Storage System

Storage system	Frequency	Percentage
Warehouse	44	36.6
Hermetic	59	49.2
Silo	17	14.2
Total	120	100.00

Source: Field Survey (2010).

Data in table 4 shows variation in the percentage of the storage system used by the rice storage farmers in Yala Local Government Area of Cross River State. The results revealed that 49.2% of the farmers were into the use of the Hermatic storage, which is adjudged as the best storage system, 36.6% use the warehouse system, while 14.2% use the silo method of storage to preserve their rice.

Table 5:Distribution of Respondents According to Storage

Capacity of storage	Frequency	Percentage
1000 bags[a]	102	85.0
500 bags	3	10.9
200 bags	1	4.1

a = 50kg bags

Source: Field Survey (2010)

Table 5 shows the storage capacity of the rice farmers in the study area. Majority of the farmers (85%) had storage capacity of 1,000 bags, while about 11% had storage capacity of 500 bags and 4% had storage capacity of 200 bags. This implies that farmers in the area store large quantities of their rice produce.

Table 6: Storage Period of the Respondent

Storage period	Frequency	Percentage
<5 months	34	28.3
5-9.9 months	73	60.8
10-14.9 months	7	5.8
15-19.9 months	1	.8
20-24.9 months	1	.8

Source: Field Survey (2010)

Data in table 6 shows the storage period of the respondents, which ranges from < 5 months (28.3%), 5-9.9 months (60.8%), 10 -14.9 months (5.8%) 15 -19-9 months (0.8%) and 20 -24.9 months (0.8 %). This implies that majority of rice farmers store their product for about six months.

Table 7: Application of Chemicals duringStorage

Chemical application	Frequency	Percentage(%)
Yes, I apply chemical on my farm	50	41.7
No, I did not apply chemical	66	55.0

Source: Field Survey (2010)

Data in table 7 shows respondents who apply chemicals during storage. 50 of the respondents (41.7%) applied chemicals,while 66 respondents (56.0%) did not. Further investigations reveals that rice farmers who did not apply chemical have the belief that chemicals could kill human beings, while lack of knowledge of application method and high cost of the chemicals were also reasons for not applying chemicals by farmers.

REGRESSION ANALYSIS TO ESTIMATE THE GROSS RETURN ON STORAGE

Regression equation was used to estimate gross returns and cost of operation.The result of the regression analysis shows that gross returns on storage (t = 4.130) is significant at 0.05 probability level. This implies that return on storage is high.

Table 8: Regression Analysis Showing the Gross Return on Storage.

Variable	Unstandardized Coeff.(B)	Std. Error	Standardized Coeff. (B)	T
Constant	.862	1.55		5.552
Average Annual cost of storage	.321	.078	.470	4.130

T is significant at = 0.05 Dependent variable = average annual returns.

R2 = .221

Adjusted R2 = .208

df= 1

CONCLUSION

The result of the study shows that rice business depends on the quality of rice, storage facilities and the fund used in the business. Gross return on storage is high. The major constraint is lack of finance, which may discourage storage business, thereby reducing storage duration.

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THE NIGERIA RICE SECTOR: CHALLENGES TO ACHIEVING SELF-SUFFICIENCYAND THE WAY FORWARD – A CONCEPT APPROACH

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ABSTRACT:
The paper reviewed rice demand, supply and production challenges encountered in the effort to achieve self-sufficiency in Nigeria. The paper noted that the demand for rice in Nigeria was not static but varied with the population and a shift in food resource in preference for rice. Major constraints to rice self-sufficiency, besides government policies, included field production-related problems such as soil infertility, inadequate and high cost of mineral fertilizers, high cost of insecticides, herbicides and labour. Ineffective weed control by herbicide use in some locations due to high rainfall and high incidence of red rice, insect pests, particularly stem borers as well as avian pests, especially the weaver birds (Quelea quelea), reduce rice yield. Incidence of rice blast (Pyricularia grisea), bacterial leaf blight and rodents, particularly the grasscutter/cane rat (Thryonomys swinderianus) also reduce the yield of rice. High cost of labour for land preparation, weed control, input application and harvesting need to be adequately addressed. Inadequate post-harvest handling, processing and sorting/grading facilities and losses due to infestation by storage insects and mice, were also identified. It was concluded that all the stakeholders in the rice sector must rise up to the challenges, with governments playing a leading role. Research institutes, rice farmers, input and machinery suppliers, processors, importers, marketers and consumers must combine efforts in facing the challenges. Emphasis must be placed on the supply of farm power (e.g. power tillers), production input, and processing plants at moderate cost, as well as effective pest control. Such a united and well coordinated effort would substantially step up the nation's rice self-sufficiency beyond the current ratio of 0.64.

INTRODUCTION

Rice (Oryza sativa L.) is one of the world's most important cereal food crops and feeds about half of the human race (Hawsworth, 1985). FAO (2004) identified rice as a very important primary food source and rice-based system as essential means for food security, poverty alleviation and improved livelihood. Rice is reported to be the most rapidly growing food source in Africa and of significant importance to food security in an increasing number of low income food-deficient countries (Iheke, 2010).

ANNUAL DEMAND AND SUPPLY OF RICE IN NIGERIA

Nigeria's annual demand for rice is estimated at 5 million tonnes of milled rice (FAO 2004), while production level is about 3 million tonnes with a self-sufficiency ratio of 0.64 (Africa Rice Center 2008), resulting in a gap of 2 million tonnes, which is hardly bridged by importation. The per capita rice consumption in the country is estimated at 21kg (Ukwungwu 2004). Nigeria is the second largest importer of rice in the world after the Philippines (Adigbo, 2010) and in 2008 alone, the Nigerian government proposed to spend 80 billion Naira on rice importation, in order to meet consumption in the country (Nigerian Tribune, 2008). Yet Nigeria has the potential of being rice self-sufficient, as virtually all the agro-ecological zones in the country are suitable for rice production (Anonymous, 1997). The potential area for rice production in Nigeria is estimated at between 4.6 and 4.9 million hectares (Imolehin, 1991).

The population of Nigeria was put at 140 million in 2006 and is on the rise going by the estimated annual increase of 2.8%.The Nigerian population is expected to exceed 180 million by 2016. That would mean more need for rice (Table 1). The world rice consumption is growing at the rate of 4% per year, although rice consumption in Africa is growing at even faster rates; about 5.08% in Nigeria between 2001 and 2005 (Africa Rice Center, 2008).

Therefore, a conservative consumption rate of 4% per year means that Nigeria would require between 6.411 and 7.117 million tonnes of milled rice to meet consumption need in 2015. If the present import scenario persists, huge import bill would be expended on rice.

The future is even gloomier for the country, given the fact that rice prices in the world market have risen by as much as 40% and are predicted to continue to rise. The quantity of rice available in the world market is relatively small compared to total world production. It has been reported that world rice stocks have decreased by 30% per year and if the current trends continue, world ending stocks of rice will diminish to zero between 2015 and 2020 (Africa Rice Center, 2008). Nigeria is already hit by the current global food crisis and is releasing food grains from the strategic grain reserves to cushion the effect of rising food prices. Given the fact that imported rice attracts 100% tarrif and 10% surcharge, Nigeria consumers should be prepared to spend a substantial part of their revenue on rice if we fail to produce to self-sufficiency level.

Table 1: Projected population change and rice demand in Nigeria

Year	Estimated population (million)	Estimated rice demand (million tonnes)
2006	140	5.0
2007	144	5.2
2008	148	5.4
2009	152	5.6
2010	156	5.9
2011	160	6.1
2012	165	6.3
2013	170	6.6
2014	175	6.8
2015	180	7.1
2016	185	7.4

Adapted from Okolo (2003) and Africa Rice Centre (2008).

SOME MAJOR CHALLENGES TO RICE SELF-SUFFICIENCY IN NIGERIA

(1) Inadequate availability and high cost of fertilizer: Carsky and Ajayi (1992) noted that a key component in any sustainable cropping system is the maintenance or restoration of soil fertility. Mineral fertilizer in some parts of Nigeria has become increasingly unavailable and unaffordable (Valerie and Crawford, 2007). Nigeria's current fertilizer use is about one million tonnes per annum, while the projected demand estimate is 3.7 million tonnes (Aba, 2010). Average worldwide rates are 93 kg/ha of NPK, while the rate for Nigeria is about 13 kg/ha. Poor distribution system often places the few available quantity in the hands of black market operators in some parts of the country who sell a bag (50 kg) of NPK fertilizer at between N5,000 and N7,000. There is the need to re-strategize fertilizer distribution through effective monitoring to benefit rice farmers. If possible, commodity (rice) distribution method should be adopted in the distribution process.Complementary use of inorganic and organic fertilizers should be practiced.

(2) Seed quality and availability: Increasing yield per unit area can only be achieved through the use of improved seeds, coupled with good agronomic practices (Okolo, 2003). Two key areas of concern in the rice seeds are red rice contamination and seed viability. Weedy rice includes a range of biotypes. The wild species,Oryza barthii and O. longistaminata or weedy biotypes from the cultivated O. glaberrima are among the worst weeds in West Africa and Sahel. Red rice contamination of commercial seeds, when sown in commercial farms, require much labour for rouging and when allowed to seed, contaminate the field and making subsequent cultivation difficult. There is need for regular inspection by officials of the National Seed Council, of seed stores and farms of seed companies meant for producing commercial seeds. Also to be guaranteed, is 80% minimum germination of seeds sold by seed companies, absence of noxious weed seed/propagules and other crop “seeds”, insect pests, particularly storage insects.

(3) Insect pests: Stem borers constitute a major group of rice pest and they are categorized into (a) Lepidopterous stemborers (larvae of various moths) and (b) Dipterous stemborers (stalk-eyed borers – Diopsis spp) (Ukwungwu, et al., 2004). They are reported to cause losses of 31 to 38% (Kok and Varghese, 1966), especially in the rainforest agro-ecology where the persistence of insecticide application is highly compromised by frequent rainfall.

Percentage damage to rice is increased by combined attack of other insects such as the lady bird beetles (Epilachna spp.), where adults and larvae feed on the foliage, causing white streaks or patches devoid of chlorolphyll. Breeding cultivars of rice that are resistant to stem borers and production of bio-pesticides in commercial quantities would be helpful. The adults of stem borers should also be targeted when spraying, while integrated methods, like sweeping with nets can be employed.

(4) Diseases: Rice blast (Pyricularia grisea), brown spot (Helminthosporium oryzae) and sheath blight (Rhizoctoniaspp.) are widespread, causing 50-80% yield losses (Raymundo, 1980). Good plant nutrient management, use of resistant/tolerant varieties are among the best options against disease problems (IRRI, 1984). Rotating varieties have been reported in shealth blight management as well as the use of Azozystrobin (marketed as Quadris) to control blast, sheath and panicle blight (Nood, 2001).

(5) Weeds: This contribute about 50% to yield gaps (WARDA, 1996), while Ukwungwu et al, (2004) reported weed-related losses of 33 - 100%, depending on the rice ecology. Effective hand weeding in rice requires 250 to 780 mandays per hectare (Ukwungwu et al., 2004) and farmers tend to abandon crops to weeds after failing to meet the labour requirement for weeding. Reduced crop row spacing that provides supplemental weed control, can help reduce production costs (Grichar et al., 2004). Narrow rows increase weed control by increasing the competitiveness of a crop with weeds and by reducing light transmittance to the soil surface (Tharp and Kells, 2001). In addition, sowing on clean seed bed/field is encouraged.

(6) **Vertebrate pests:**

(i) Rodents such as rats, mice, squirrels, cane rats and porcupines dig up and eat newly sown seeds or cut off rice seedlings and mature stands, causing yield losses. Periodic use of village hunters to comb the area is encouraged.

(ii) Bird pests such as Ploceus cucullatus (Muller); Ploccus melanocephalus;Quelea quelea, Quelea erythrops,Euplectes afer,Passer griseas etc. (Ukwungwu, 2004) can completely destroy rice fields. They move long distances in large numbers and eat about half their weight of seeds everyday (Burwa et al., 2010). The most successful methods of quelea control are reported to be chemical control by aerial spray and ground-based explosions (Burwa et al., 2010) which are very expensive. Recently, Burwaet al.. (2010) suggested harvesting quelea birds as a control measure. Considering the huge number involved and their migratory capability, it is hardly possible to reduce their number to non-major pest level. A long-term measure may involve the cooperation of environmentalists, ornithologists and agriculturists to work out a technology of baiting their food/drinking water, such that infertility is induced in the females to lay infertile eggs. Gradually, their population would be decimated to a non- major pest level. Use of a single variety at a time shortens bird scaring period.

(7) Inadequate farm mechanization: At present, most of the rice in the country is produced by peasant, low resource-based farmers, who depend upon their muscle-power and their household for labour. Emphasis should be placed on the use of farm power (e.g. power tillers) and mechanization, if the production level must increase. Land preparation, sowing and harvesting must be mechanized. Harvesting constitutes one of the major operations in rice farming that is labour intensive. Designing and fabricating simple, light, hand operated or back-pack machines that hasten rice harvesting by resource-poor rice farmers would increase farm holdings and productivity.

(8) Post-harvest handling and processing: Adequate storage facilities that protect paddy on transition to milling should be provided by government to farmers or cooperatives who cannot afford them.

At present, the national processing capacity is low and most of the village mills have malfunctioned, resulting in increased wastage of harvested paddy. Governments at various levels should support/provide modern rice processing mills that will deliver high quality parboiled milled rice that can compete favorably in both domestic and export markets.

It is believed that when the various field production, handling and processing challenges are addressed and governments and all the stakeholders in rice sector come to the realization that achieving self-sufficiency in rice production requires determined effort, would Nigeria become self-sufficient in rice.

CONCLUSION

Farmer's field days should be organized by the National Cereal Research Institute (NCRI) and the National Seed Council (NSC) at NCRI substations annually to interact with farmers, evaluate their problems and provide feedback through research.

All the stakeholders in the rice sub-sector of agriculture must put in determined efforts in areas of research, input supply, information dissemination, machinery provision, land aggregation, pest and quality control, for the achievement of rice self-sufficiency. It is concluded that efforts should be stepped up on pest control and processing. When these are achieved, our sufficiency ratio will improve substantially.

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RICE-AFRICA

* Rice is a central part of many cultures and some countries even credit rice cultivation with the development of their civilization.

* It is the staple food for more than half of the world population.

* Rice is the world's most consumed cereal after wheat.

* It provides more than 50 percent of the daily calories ingested by more than half of the world population.

* It is the most rapidly growing source of food in Africa and is of significant importance to food security in an increasing number of low-income food-deficit countries.

* Of the 10 million metric tonnes of rice imported into Africa, Nigeria accounted for 2 million metric tonnes, which contribute to the 5 million metric tonnes consumed annually in the country.

* Africa and Asia import over 85% of the internationally traded rice volume at about $1,000 per tonne.

* Although 240 million people in West Africa rely on rice as the primary source of food energy and protein in their diet, majority of this rice is imported, at a cost of USD 1 billion. Self-sufficiency in rice production would improve food security and aid economic development in Africa.