FACTORS INFLUENCING ADOPTION OF AGRONOMIC PRACTICES OF NERICA RICE PRODUCTION IN THREE LOCAL GOVERNMENT AREAS OF KANO STATE, NIGERIA

BY

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DECLARATION

I hereby declare that this thesis titled **"Factors Influencing Adoption of Agronomic Practices of NERICA Rice Production in Three Local Government Areas of Kano State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been acknowledged in the text and a list of references provided.

…… ……

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CERTIFICATION

This thesis titled **"Factors Influencing Adoption of Agronomic Practices of NERICA Rice Productionin Three Local Government Areas of Kano State, Nigeria**" by Sani Faska Abdul meets the regulations governing the award of the Degree of Master of Science in Agricultural Extension and Rural Sociology Ahmadu Bello University Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This research work is dedicated to my parents, late Honorable Abdullahi Bala and Hajiya Zuwaira Usman

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ABSTRACT

This study was conducted to evaluate the factors influencing the adoption of NERICA rice agronomic practices among farmers in three selected Local Government Areas of Kano State, Nigeria. The specific objective were to: Determine the rate of adoption of NERICA agronomic practices; determine factors influencing adoption of NERICA rice; determine the relationship between adoption of NERICA rice and yield, income and level of living of the farmers and identify the constraints encountered by the farmers in adoption of NERICA rice agronomic practice. The study areas were: Tudun Wada, Garin Malam, and Kura. These three Local Government Areas are located between latitudes $11^{0}15^{1}$ N11^{o} 16^{1}N and Longitudes 8^{0}251E, $8^{o}28^{1}$E of the equator respectively. A multistage sampling method was employed: Firstly, three LGAs with highest level of NERICA rice production were purposively selected; secondly, two villages were purposively selected on the basis of being the most prominent NERICA rice producing areas from each LGA. Thirdly, 20% of the farmers (548) engaged in NERICA production was randomly selected to get 110 respondents for this study. It was found that 96%of the respondents were males with mean age of 38. About 93% of the respondents adopted NERICA varieties and seed rate; spacing was adopted by 51% and weed control adopted by 63%. Multiple regression analysis revealed that the level of education, age, family size, extension contact, farming experience, access to credit facilities, and membership of the association. Technological characteristic like complexity, and compatibility collectively contributed 46% to the variability in the adoption of NERICA rice agronomic practices. The survey found that 22% of the respondents obtained ₦31, 000 and above as increase in income due to adoption of NERICA rice. It was also found that 53% of the farmers reported higher cost of fertilizer, 47.3% poor credit facilities, 34% inadequate extension services, 16.4% insufficient agrochemicals as major problems. It was recommended that farmers should be encouraged to adopt agronomic practices as a package to improve their level of production through participation in extension training and advisory services. It was therefore adoption of NERICA rice agronomic practices was found to have significant effects on, yield, income and level of living of the respondents. Based on this success it is hereby recommended that the NERICA rice productions should be scaled up, replicated in other Local Government Areas within the State.

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ABBREVIATIONS

ADC= Agricultural Development Centre

ADPs= Agricultural Development Programmes

ARI= African Rice initiative

ATE= Average Treatment Effect

CBN= Central Bank of Nigeria

DAP= *Diammonium* Phosphate

DAS= Day after Seedling

FOA= Food and Agricultural Organization

FMARD= Federal Ministry of Agriculture and Rural Development

GDP= Gross Domestic Product

ICT= Information and Communication Technology

JEAA= Joint Awareness Access and Adoption

LGAs= Local Government Areas

MAAIF = Ministry of Agriculture Animal Industries and Fisheries

MFPED = Ministry of Finance Planning and Economic Development

MNDP = Multinational NERICA Dissemination Project

MANR = Ministry of Agriculture and Natural Resources

NARS = National Agricultural Research System

NASC = National Agricultural Seed Council

NASS = National Agricultural Statistic Services

NCRI = National Cereal Research Institute

NERICA = New Rice for Africa

NFRA = National Food Reserve Agency

NGOs = Non-Governmental Organizations

NSPFS = National Special Programmes on Food Security

PVS = Participation Varieties Selections

PCU = Project Coordination Unit

PSB = Population Selection Bias

PPMC = Pearson's Product Moment Correlations

RIFAN = Rice Farmers Association of Nigeria

SSA = Sub-Sahara Africa

WARDA = West African Rice Development Association

CHAPTER ONE

I NTRODUCTION

1.1 Background to the Study

Rice is regarded as one of the most important cereal grains in many regions of the world and reported to be the most cultivated crop and consumed for more than 10,000 years ago all over the world (World Bank 2001). Total land area under rice cultivation globally was estimated at 150,000,000 hectares with annual mean production of 500,000,000 metric tons that represents 29% of the total output of grain crops worldwide (Tsuboi, 2004, Kuangdi and Guofang, 2003).

Surveys conducted in 2009 by the National Agricultural Research Systems (NARS) and the National Agricultural Statistical Services (NASS) in 21 Sub-Saharan African countries discovered that land area under NERICA rice production was 140,000 hectares in Guinea and 244,000 hectares in Nigeria. Diagne *et al*. (2006) and Adegbola *et al*. (2006) estimated that the total land area under NERICA rice cultivation was 51,000 hectares in Guinea in 2004 and 5,000 hectares in Benin in 2003. The National Food Reserve Agency (NFRA) of Nigeria reported 186,000 hectares under NERICA 1 cultivation in Nigeria in 2007. The Uganda National Agricultural Research Institute, cited from the Statistics Office in the country's Ministry of Agriculture that 35,000 hectares under NERICA 4.

Before NERICA rice biotechnology research program was set up in 1991, rice was the staple food crops for more than half of the world's population, and some 240 million people in West Africa were dependent on rice as their primary source of food energy and protein (Kijima, *et al*, 2008).

WARDA's objective was to produce a rice variety which was better suited to the harsh conditions in Africa, there are two basic traditional rice varieties available to African farmers; Native African rice (*Oryza glaberrima*) cultivated in the region for 3,500 years, and Asian rice (*Oryza sativa*); introduced into Africa by Portuguese sailors 500 years ago, West African scientist succeeded in crossing two rice varieties to produced "NERICA" that combines the ruggedness of local African rice species with the high productivity of the Asian rice. The panicles of "NERICA" holds up to 400 grain compared to the 75- 100 grains of its African parent, NERICA also matures 30-50 days earlier than traditional varieties. Communication and Information Office of the African Rice Center indicated that "Hundreds of NERICA lines have been developed and they are true-breeding" in other words, farmers can save and replant seeds every year, poor farmers are therefore getting the benefit of hybrids rice without having to pay for it every year. Participatory research is the NERICA successful story where more than 1300 farmers took part in the 1998 project to start growing the NERICA rice varieties in Guinea (Dalton and Timothy, 2004).

NERICA 1, NERICA 2, NERICA 3 and NERICA 4 were the top varieties selected by farmers for trial in Benin, Burkina Faso, Cote 'd' Voire, Gambia, Ghana, Mali, Sierra Leon and Togo. Within West central Africa; Cote'd' Voire released NERICA varieties in year 2000 and Nigeria released in 2003. Farmers in the Gambia, Guinea and Sierra Leon are growing several NERICA varieties. In Benin, Gambia Mali and Togo several NERICA are under extension. Uganda has released a NERICA variety as "NERICA 3" Ethiopia Madagascar, Malawi, Mozambique and Tanzania are evaluating several NERICA varieties "in trials, were getting yield as higher as 2.5 tons per hectare at low inputs by minimum increase in fertilizer use (Anon, 2005)." He further "anticipate a

rapid growth of rice production, leading to self- sufficient within 3-4 years, we expect improved and nutrition for the rural population and more affordable domestic rice for the urban population.

1.2 Statement of the Problem

Rice is a traditional crop in Nigeria, but local production is limited, while internal demand is very high because of the increase in population growth. Despite the introductions of improved agronomic practices through research and extension services most farmers still use traditional methods of production of rice which is highly drudgery and inimical to the farmers' economic development. The low yield of local rice compared with other regions of the world is of great concern where the government is committed to funding agriculture and allied areas. Not deterred by the fact that rice has been grown in Nigeria for a long time with little to show when compared with the annual rice importation cost. For instance, a lot of rice productions technologies have been developed by research Institutes and disseminated to farmers by extension agencies. It is therefore imperative that a study is undertaken to show the extent to which farmers have adopted the NERICA rice agronomic practice as its production gaining popularity in Nigeria. It is against this backdrop that this study of adoption of New Rice for Africa (NERICA) was conducted in three Local Government Areas of Kano State to ascertain levels of adoption of agronomic practices by NERICA rice farmers in the study areas. The following research questions were raised:

i. What are the socio-economic characteristics of NERICA rice farmers?
ii. What is the rate of adoption of NERICA rice agronomic practices by the farmers?
iii. What are the factors influencing the adoption of NERICA rice agronomic practices?

iv. What are the effects of adoption of NERICA rice agronomic practices on yield, income and level of living of farmers?

v. What are the constraints encountered by farmers in adoption of NERICA rice agronomic practices?

1.3 Objectives of the study

The broad objective was to evaluate factors influencing adoption of agronomic practices for the production of NERICA rice among farmers in three selected Local Government Areas of Kano State, Nigeria. The specific objectives were to:

i. describe the socio-economic characteristics of the NERICA rice farmers;

ii. determine adoption rate of the agronomic practices by NERICA rice farmers;

iii. determine factors influencing adoption of the agronomic practices for NERICA rice farming;

iv. determine the relationship between adoption of agronomic practices of NERICA rice, yield, income and level of living of the farmers,

v. identify the constraints encountered by the farmers in the adoption of NERICA rice agronomic practices.

1.4 Justification of the study

Inadequate production oriented innovations tend to limit the possibilities of improving and rehabilitating agricultural production and of stabilizing and improving the prospectus of the rural producers. This study intended to provide information on the factors that aid or hinders adoption of the "NERICA" rice agronomic practices. The findings of this study would educate farmers on how to improve NERICA rice production through informing them of agronomic practices found most appropriate for their adoption because it has been tried, tested and recommended to offer the best yield,

profiting and assured of improving farmers' livelihood. The study shall in addition serve as a baseline information on NERICA rice varieties, where available in the study areas, and practices that influences productivity on farms. The findings of the study shall equip policy makers during decisions making concerning on NERICA rice farmers by informing them on the numerous relationships and effective diffusion delivery systems. The findings shall be relevant to researchers, extension agents and stakeholders concerned with the issues of food security. The study shall serve as the basis for the development of further research while adding to the existing body of knowledge.

1.5 Research Hypotheses

Ho_1: There is no significant relationship between socio-economic characteristics of the farmers and rate of adoption of NERICA rice agronomic practices.

Ho_2: There is no significant relationship between the adoption of NERICA Rice agronomic practices and yield, income and level of living of the NERICA rice farmers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Socio-economic Characteristics of NERICA Rice Farmers

Socio-economic characteristics are factors or variables that determine exposure to farmer's participation in agricultural project implementation (Banjol *et al*., 2003). Igbokwe (2000) in his study of socio-economic factors associated with adoption of agroforestry in North-west zone of Nigeria reported that off-farm income and land use security affected adoption. Other researchers that include Atala (1980), Jibowo, (1980), Igbokwe, (2000) and Agbelemoge *et al,* (2001) have revealed socio-economic characteristics of farmers to comprise farming experience, age of the farmer (years) education (school years), tenure status, farm income, family size, family labour, extension contact per season, access to credit and extent of commercialization as prominent formal channel of contact with farmers in Nigeria. According to Dipeolu (2000) these formal channels are also the yard stick commonly utilized to adjudge the extent of diffusion and the adoption of modern agricultural technologies. For instance, age of farmer is expected to influence adoption of innovations in any direction depending on farmer's disposition, educational level and experience. According to Appleton and Simon, (2001) younger farmers are more likely to be interested in adopting new technologies if they are not constrained by limited cash resources, while older farmers are less likely to be able to use new technologies if they require extra physical labour and/or older farmers may be less interested because they have less need for extra income.

Agribusiness Development Centre (ADC) (2001) study report distinctively on socio-economic characteristics of farmers to include age which contributed positively when

the level of farmer's education and experience in farming is high, and negatively, if the level of education and experience of farmers is low. Education is expected to affect the level technology adoption positively through effective skill acquisition in choosing better inputs (Anon 2005). Agribusiness Development Centre ADC (2001) discovered from an independent study that sampled population of farmer using a survey method on 1375. Ninety two percent (92%) of the respondent were males while only 8% of the samples were female-heads of household. A total of 57.1% had primary education, 30.6% secondary, 4.1% tertiary level education and 0.2% vocational and university education, and 8% did not attend school at all. The majority of respondent household heads (88.4%) were in the age range of 20 to 59 years with a mode of 40; while none of the respondents was older than 79 years.

Tenurial arrangement may influence the extent to which a given crop could be cultivated, in view of the problem posed by supply of land in Nigeria agriculture (ADC, 2001). Forster, Kayayo and Pookat (2004), viewed inheritance as the most common form of land ownership; it can be passed from one generation to the other. This arrangement is expected to affect technology adoption positively. For instance, MAAIF and MFPED (2004) surveyed and captured information on total landholding by households and the amount of land allocated to rice farming specifically in Uganda. The average household landholding sizes for Luwero, Kamwenge, Kibaale, Kiboga, Lira and Iganga were respectively, 6.1, 4.6, 4.3, 3.9, 3.6 and 1.95 hectares. The mean percentage of land allocated to rice varied from 12.2% in Kamwenge (a district that has newly taken on to rice farming), to 28.0% and 29.1% in Lira and Iganga respectively with details for the rest of the surveyed districts.

Farming experience could take on either negative or positive sign depending on the length of period. It is expected to demonstrate increasing returns (Tiamiyu, Akintola and Rahji, 2009). In Kano State, Voh (1979) indicated high levels of occupational segregation; on rice cultivation it is glaring on value chain "from seed to plate," as well as on age, gender and family size which are important determinants of appropriate activities. Production is dominated by men, most likely because of their relative freedom of mobility. The survey also showed that majority of respondents were married (83%), with 6% being single and 11% were either widowed or separated (divorced). This result indicated that the sample population of rice farmers was relatively stable. The family size of the respondent households varied from a minimum of 2 to a maximum of over 30 members with a mode of 6 members. Additionally, the sampled households had a relatively high numbers of dependents, the majority being within the lower age group up to 20 years and the rather elderly, over 60 years.

Voh (1979) and Atala (1980) discovered that socio-economic factors like age, household size, formal education, income, cosmopolitans and community status were related to adoption. They equally found that non-adopters were older than adopters. Akanya (1989) concluded that certain socio-economic variables were severally related to adoption of agricultural innovations. Furthermore, Ekenta (2004), stated that adoption of technologies is influenced by certain factors and is a function of farmers' characteristics, extension agency and technologies themselves as material components.

Similarly Awogbade (1981) discovered that family/village structural arrangement in which the head of household acts as both the legal and political spokesperson on all issues, and where his decisions often influence others to either adopt agricultural

innovations or not is a great determinant of successful adoption. Onazi (1973) reported that in Northern Nigeria non-adopters of agricultural practices are reluctant to give up their old ways even with unfavorable producers' prices. By and large, farmers' response to agricultural innovations is attributable to a number of institutional, national economic and environmental factors that comprised of credit, extension agent, input delivery, land tenure and sources of information. Akinola (1986a), Okwoche *et al*,. (1998) established positive relations between farmers' adoption behavior and access to credit, while in addition Akinola (1986b) attested same for product prices, quantity of inputs available for sale, number of active selling points and advertisement. Similarly, for such communication factors that include the period of awareness and cosmopolitanism, Iyere (1985), Akinola (1986a), Umeh (1998), Adekoya and Ajayi (2000), Musa (1998), Akinola (1986b), Asifat (1986) and Chukwu (1995) proved negative relations exists between household/family size, membership of cooperatives, social position/cultural positioning, extension agent contact, cost of innovation and difficulty in use of innovation and adoption behavior. Mijindadi and Njoku (1985) in their study found that the significant associations between extension contact, membership of associations, credit availability and input delivery and farmer's awareness and adoption of horticultural innovations. Atala (1983) observed in his study of knowledge and use of recommended sorghum practices by farmers in Gusau Agricultural Development Project area that two agronomic practices (thinning and spacing between holes) were not adopted because they conflicted with traditional practices of the farmers.

2.2 Rate of Adoption of NERICA Rice Agronomic Practices by Farmers

Food and Agriculture Organization (FAO), (2006) reported that rice is an annual crop and the second highest worldwide production after maize. To sustain and/or attain the

most cultivated and produced crop, farmers have to adopt to the appropriate agronomic practices that is from site selection, land preparation, recommended NERICA upland varieties, viability testing and seed requirements, as well as seed treatment, sowing method time, spacing and seedling rate, fertilizer type and method of application. Mechanical and chemical weeds control, insect pest and disease control, harvest, threshing, drying and storage conditions (Normal and Otoo, 2006).

The Rice Research and Development Network for West and Central Africa (2004) discussed NERICA agronomic practices as follow:

Site selection*:* select land site in an ecological zone with at least 14-20mm of five-day rainfall during the growing cycle, and fertile land with good water retention capacity (contains some clay and/or organic matter, that is loamy soil) (Fashola, Imolehin and Wakasuki 2007). Similarly, Abadie, Alberto and Imbens, (2006) reported that cultivation of rice is influenced by site-specific factors like the available nutrients in the soil, most farmers claimed that intensification of rice cultivation reduces soil fertility over time. The declining yields obtained by farmers strongly attest to low fertilizer use linked to high cost, inaccessibility and to farmer's ignorance about fertilizer role and its application.

Among the fertilizers (DAP, SSP, UREA and MOP) commonly used, *Diammonium phosphate* (DAP) and Urea are the most frequently used (Akande 2001). World Bank: PRSP Progress Report (2001). Indicated that a significant number of farmers (56.5%) carry out soil enrichment using organic residues such as chicken refuse, rice straw, and cow dung, and 11.8% apply both organic and inorganic sources. However on the time of

fertilizer application, responses widely varied; with the majority applying DAP at planting time and urea 30 - 40 days after planting. Farmers had different application rates but the majority (62.9%), are applying insignificant quantities ranging from 10-20 kg/ha indicating that the majority have little knowledge about fertilizer use. The time and rate of application are critical in exploiting the yield potential of rice. According to Mendola (2007) most of the respondents expressed need for training on rice input use and that the importance of fertilizers in increasing rice yields needs to be demonstrated.

Land preparation*:* Land preparation can start in March, depending on rain. Mechanically, to make a good till if land is flat, plow and disc once. When land is sloppy, harrow two weeks after plowing to allow the weeds to die, divided the field into plots of $50m^2$ or $100m^2$ and construct bunds, depending on the slope, to accumulate rain water and also to allow good drainage, level the field to reduce erosion. Where manual cultivation hoe are used to remove thick bush but leaves small debris and weeds to be incorporated as manure when hoeing (WARDA Nigerian station, 2006).

According to Blundel, Monica and Meghir (2001), upland rice cultivation starts with land clearing in January and July for the first and second seasons respectively whereas in lowland rain-fed rice, this activity is done in January and late August. Blundell *et al*. (2003), reported that in Iganga where lowland rain-fed rice is grown only for one season, land clearing is often done in January through to February. Analysis of labour distribution showed family labour being predominantly employed in land clearing contributing 59.8%, whereas contracted labour and exchanged labour contributed 16.2% and 1.7% respectively. In some circumstances a combination of family labour and contracted labour were utilized; this contributed 14.1% of the rice farm labour (Blundell,

and Powell, 2004). Bloom, (2005) reported that family labour contributed 46% of the labour requirements during first plowing, followed by a combination of both family and hired labour, which contributed 20% of the labour requirements. Hired labour and labour exchange each contributed 30.8% and 1.8% respectively.

The results of the number of times a rice farmer plowed his/her rice field before planting, showed that only 6.9% plowed once, 61.3% plowed twice, 27.9% plowed thrice and 3.9% plowed four times before planting The essential difference in numbers of times the rice field was plowed before planting is largely dictated by the environment in which the rice was to be grown. Over 68% of the farmers who plowed their fields once or twice grew upland rice while 31.8% that plowed thrice or even four times, grew lowland rice. Most respondents who had experience on both low- and upland rice management, reported a lot more strain, labour and time required in low-land compared to upland rice cultivation (Oryokot, Forster, Kayayo and Pookat 2004).

NERICA Rice Upland Varieties: Early maturity (< 90 - 100days): FARO 1, 40, 45, 54, 55 (NERICA1), 56 (NERICA2), other upland NERICA. Medium maturity (100-120 days) FARO 48, 49, 53, etc. late maturity (>120 days): FARO 25. Used a good quality seeds without insect damage or contaminants (weeds seed or other seed types) avoid seed of mixed varieties (WARDA Nigerian station, 2006).

NERICA Rice Seeds Viability Testing and Seed Requirement*:* use only filled grains of good quality for sowing add water to seeds and discard all empty grains that float in water, when seed viability is not known, a simple seed viability test should be carried out to guide the actual seed rate to use, to estimate percentage filled grains, select at

random 100 seeds from seeds lot to be sown and count the number of filled grains (Alene and Manyang, 2006).

NERICA Rice Seed Treatment*:* Treat selected seed with a mixture of insecticide and fungicide. For example, Apron Star 42 WS (*thiamethoxam* 20 g/l) at the rate of one sachet per 4 kg seeds, or any available seed dressing chemical before sowing. Other product can be used: PROCOT 40 WS (carbosulfan + carbendazim + metalaxyl-m). CALTHIO C 50 WS (thiram + chlorpyriphos-ethyl). In areas with termite and nematode problems incorporate carbofuran (Furadan) at rate of 2.5kg per hectare in to planting row. To ensure uniform application Furadan should be mixed with sand at a ratio of 1:4. Soak the seeds in water for 24 hours and incubate for 48 hours before sowing to ensure uniform seedling emergence and good establishment (NSPFS, 2004).

NERICA Rice Sowing Time method, spacing and seedling rate: According to WARDA Nigeria Station (2006) the recommended practices for NERICA sown at Savannah agro ecology to be between months of May to June; for the forest agro ecology, April to May. Sow seeds when the soil is moist, if possible, immediately after a good rain. The method of sowing NERICA is either by direct seeding: dibbling opening up a spot in the soil and sowing 5 to 8 seeds at a depth of 2-3 cm. Drilling: making a small groove, 2-3 cm deep in the soil, and sowing the seeds sparsely in the groove and covering with soil. The second method are Broadcasting: spreading the seeds on the soil surface without any specific pattern. Dibbling at 30 x 30 cm or 20 x 20 cm: seed rate: 50- 60 kg/ha. Drilling at 25 x 30 cm row spacing and 5 cm within row, seed rate: 75-80kg/ha. Broadcasting: seed rate: 80- 100kg/ha (Aduayi, Chude, Adebusuyi and Olayiwola, 2002).

Auderbert *et al*. (1998) reported that plant spacing and methods of planting significantly influence the seeding rate, optimum plant population and eventual crop yield, in the districts they surveyed, 62.1% of the farmers interviewed used drill; 11.6% dibbled, 18.6% broadcasted, and 7.2% transplanted rice. Broadcast, drill and dibble methods were widely employed in upland rice fields while transplanting was solely used in low-land rice farming. He further, reported that the preference for drill as a planting method was attributed to the following:

- Better growth due to proper spacing thus reducing congestion,
- Higher yields due to assured optimum plant population,
- Less labour compared to dibbling, though more compared to broadcasting
- Subsequent farming operations (weeding, harvesting, and pest/disease and water management) are made easy,
- Better moisture conservation ensuring in the field.

Districts surveyed discovered that farmers were being sensitized and trained on the use of the "drill method" especially for upland rice production. Many have been taught how to use the simple hand-pulled forked-rake technology to open small furrows where seeds are drilled at inter-row widths of 20 to 30cm (Mew *et al*., 2003).

Thinning Seedlings: at 2-3 weeks after sowing thin the seedlings to 2- 4 per stand for dibble-seeded seedlings, this will give the final plant density of 22 - 44 plants/m2 for 30 X 30 cm and 50-100 plant/m2 for 20 X 20 cm spacing. But maintain only seedling per stand for drill- seeded seedlings. To avoid overcrowding, ensure the distance between stand is 5 cm (final density = 80 plants/m2) (Oikeh *et al.*, 2007).

Fertilizer: fertilizer supply nutrients essential for growth, nutrition and health of the rice plant. Fertilizers can be applied in forms of organic or inorganic (mineral) or both. Organic fertilizer can be in form of manure, or compost or crop residues. Mineral fertilizers are manufactured. It is important to apply the right quantity and at the right time to obtain optimum yields and for environmental protection (Dobermann and Fairhurst. 2000).

Method and time for Fertilizer application: Aduayi, Chude, Adebusuyi and Olayiwola (2002) suggested that fertilizer use and management practices for crops in Nigeria is important, for acid soil or soils under cultivation that are likely to be deficient in P and K, apply both phosphate and potash fertilizers at final harrowing before seeding. General recommendation: apply 60 – 80 kg N, 30 kg P_2O_5/ha and 30 kg K_2O/ha. For strongly acid soil (pH $\geq$ 4.8) or soils highly deficient in P, the rate of P should be increased to 60 kg P_2O_5/ha. Always apply K although most cases show no responses to K (potash) application. Top dressing the recommended rate: 60 - 80 kg N/ha with urea. Use the moderate rate of 60kg N/ha (2½ bags urea) for soil that is low to moderately fertile, that is that recover from the follow. Use the high rate of 80 N/ha (3 ½ bags urea) for poorly fertile soil. In extreme cases, higher rate of 100-120kg N/ha (4 - 5 bags urea) may be used. For early to medium maturity cultivars, example FARO 55 (NERICA 1), top dress 60 kg N/ha from urea in two equal splits, (30 kg N/ha). Weigh 65 kg (–1½ bags) urea and apply at onset of tillering (-21 days after seeding (DAS) for first split, just after first weeding, repeat with the same amount at about panicle initiation (when the rice is pregnant), between 45- 50 DAS (FARO 55, NERICA 1) broadcast fertilizer uniformly on the soil surface (best after second weeding) (NSPFS, 2004).

NERICA Rice Mechanical and Chemical Weed Control:

Weed types in rice farming: WARDA (2007) reporting the overview of recent development in the Sub-Saharan Africa revealed that farmers are challenged by high weeds infestation which remains the serious problems in rice production. Hay and Walker (1989) reported wide range of weeds infesting rice fields to include grass weeds: *Digitaria spp., cyperus rotundus, Eleusin indica* and *Echinochloa colona,* and the broad leaf weeds: *Amaranthus* spp., *Galinsoga* spp., *Striga* spp., *Euphobia* spp., *Commelina* spp. and *Ageretum conyzoides.*

Rice fields overwhelmed by broad leaf weeds *Eleusine indica, Striga* spp., *Cyperus rotundus, Echinochloa colona* can be under control by first weeding through and within 2 to 3 weeks after emergence, using a hoe instead of cutlass (the early the first weeding is done the better). Second weeding should be done 6 to 7 weeks after emergence, before panicle initiation and second N top dressing, to minimize the effect of the weeding process on panicle initiation weed third time if necessary (Evenson and Gollin, 2003). According to Aduayi, Chude, Adebusuyi and Olayiwola (2002), chemical weed control application can be done pre-emergence with the application of *Ronstar* (*oxadiazon*) 25 (EC) 2-3 days after sowing or just after seeding at the rate of 4 – 6 liters/ha, when weeds have grown in the field, spray *Gramoxone* (*Paraquat*) at 2 liters/ha but not more than 24 hours after sowing. However, do not spray *Gramoxone* after the germination of paddy seed, to avoid killing the seedlings. At post-emergence apply *Ronstar* (PL) at the rate of 5 – 6 liters/ha at 14 to 21 days after seeding. Use *propanil* (Stan F34), *Tamarice* or *propanil-bentazon* (*Basagram*) 14 to 21 days after seeding, at the rate of 3kg/ha. With a knapsack sprayer, apply 220cm^2 of *propanil* or *Tamarice*, or 150 cm^2 *Basagram* in 6 liters of water. Any resistant weed species or newly germinating weeds like corn grass-

Rottboellia cochinnensis – should be rouged and removed from the field, (Oikeh *et al.*, 2007).

Weeding frequency and timing: Blundell and Powell (2004) findings discovered that the time of weeding initiation in the area surveyed, only 4.9% of the respondents start weeding their rice before 2 weeks after germination, 26% start weeding 2-3 weeks after germination, and 30.6% after 5-6 weeks. A few farmers (29.4%) however, start weeding after 6-7 weeks, and (2.8%) never weed rice fields at all. Farmers who wed their rice late said that they experienced a great reduction in their yields. Most farmers wed their rice fields twice. Very few farmers (8.5%) reported weeding rice three or more times. Farmers claimed that manual weeding is cost and time-demanding operation, hence the cause for weeding ones and at most twice. Rice weeding is a female domain.

Insect Pest and Disease Control: *Aduayi, et al*. (2002) found out that besides pests, rice diseases were reported among the priority constraints. The common diseases, in order of importance, include: rice blast, brown spot and sheath rot in upland rice, and rice yellow mottle virus in lowland rice. The study identified several bird control techniques that were being used by farmers, amongst which were:

• Physical chasing, shouting and scaring off, (83.5%);
• Beating sonorous bodies like tins and jericans to scare off birds, (5.8%);
• Poisoning and trapping (1.2%);
• Use of scare crows (1.3%);
• Use of tapes that make whistling sounds around rice fields, (0.6%).

Despite all the above attempts by a majority of farmers, 7.7% of the farmers according to Aduayi *et al*. (2002) indicated that they completely did nothing about the problem of

birds in rice. In rice fields, rats directly feed on rice and other seed. They pull up germinating seeds and cut or pull up transplanted seedlings. Tillers are also usually cut and chewed. Other serious rice pests cited by farmers included termites, stem borers, cut worms, grasshoppers and caterpillar,; these too causes serious loss and damage to rice crop, others comprise of stalk eyed fly larvae, stem borer and leaf folder. The best techniques for control of insects (*stem borers, Sesamia, Chilo* and *Maliarpha* species) as well as disease (blast, brown spot, grains discoloration) are to use resistant/tolerant NERICA varieties such as LAC23, ITA121, TOS4153, NERICA1, NERICA2, NERICA4, NERICA5 and NERICA7. Treat the seeds 1 – 2 days before planting to control seed-borne pathogens. Insect such as *Carabides reduviids*, dragonflies and spiders are naturally enemies (predators) of *Chilo zacconius* and should not be killed on rice farms.

NERICA Rice Harvesting and Threshing:

The chief consideration in harvesting is the degree of maturity of the grain, normally determined by measuring its moisture content using an appropriate moisture meter, the optimum harvest moisture for rice being 21 – 24% wet basis. Under tropical conditions this point is generally reached 28 - 32 days after flowering. If the crop is allowed to stand in the field after optimum maturity, severe losses occur both in the field and during milling.

As recorded during the survey, considerable amount of grain simply shatters and falls to the ground before it is harvested and particularly during rains or hot weather. Birds and rodents (the most notorious loss agents in rice farming in the country) take their share of the ripened grain, while domestic and wild animals may stray into the fields causing further damage. Additional losses come about during the harvesting process itself,

because the grain is so loosely held on the panicles. The problem is aggravated by the poor traditional harvest method based on the rudimentary hand-held sickle, a tool used in rice harvesting by 55.7% of the farmers interviewed, with 33.8% of the farmers report using hand-held knives. Harvesting itself is done by cutting the rice at stem base or middle 54.1%, and head cutting at 43.3%. The survey also established that rice harvesting is dominated by women (over 85%) while children play a disproportionate role in bird scaring (over 90%), to the extent that in some districts they are "detained" in bird-scaring tasks at the expense of participating in the current "universal primary education" program by government.

Oikeh, *et al.* (2007) indicated that rice is ready for harvest when the grains are hard and are turning yellow/brown that is about 30 – 45 days after flowering or a month after 50% flowering, cut the stem with a sickle about 10 – 15 cm above the ground, lay harvested rice crop in upright position for drying before threshing. Thresh immediately after harvesting to avoid losses, Use whacking frames or mechanical devices, but avoid threshing on bare floor to prevent the introduction of sand, pebbles and other foreign matter. Thresh on a mat or tarpaulin over concrete floor by flailing (beating rice against the floor, or against a stick or drum). Thresh carefully and avoid dehusking the grains.

Postharvest loss-levels

The normal sequence in the handling of rice crop after it matures is harvesting and threshing, preliminary cleaning, transporting home or to a drying yard, drying, cleaning of the dried crop, storage, milling, and/or distribution to the market or retention for farm family consumption. Severe loss can occur most when traditional methods of rice handling are used. Chandler (1979) reveal that 13 to 34 percent of the crop lost during harvest and postharvest operations in several South and Southeast Asian countries are in

the following proportions: during harvesting and threshing, 5 to 15 percent; in processing (parboiling and milling), 3 to 7 percent; and during handling and transportation 1 to 3 percent. Other important losses are grain quality deterioration, under-utilization of by-products, and financial losses due to inefficient postharvest operations.

Rice by-products of rice of economic and market value include husks and bran. It can be milled into flour, used for starch, as beverages, oil and glue. Therefore, making rice farming and business a viable enterprise where farmers, millers and government agencies can increase the efficiency of all phases of rice production from handling, harvesting to final delivery to consumers (Rowland and Whiteman 1993).

Drying and Storage Conditions: Dry paddy properly to a safe moisture content of 13 – 14% by spreading in a thin layer (2 – 3 cm thick) on clean concrete floors, mats or tarpaulins and turning over periodically. Sun-dry slowly for 2 – 3 days to reduce breakage during milling, on a clear bright day, sun- dry for one day (about 9 – 10 hrs) only by spreading paddy thinly on clean concrete floors, mats, or tarpaulin. Use a mechanical drier if available; avoid drying on bare floors or roadside, the main source of contamination with sand pebbles, stone and other foreign matter that can reduce the quality of rice. Good storage practices include: store at 65% relative humidity, store rice at a temperature within 10◦ F (5. 5◦C) of the average monthly air temperature and below 60◦F (15.6◦) as long as possible during the year. Design and operate aeration system to maintain uniform rice moisture and temperature, store only well cleaned rice, inspect rice regularly during storage, (Federal Department of Agricultural Land Resources and National Special Program on Food Security, NSPFS, 2004).

2.2 Rate of Adoption of NERICA Rice Agronomic Practices

The NERICA varieties were first introduced to Nigerian rice farmers in 1999 through a three year Participatory Varietal Selection (PVS) trials programme in both upland and lowland ecologies. During the first year, a centralized village plot was identified with local farmers where a rice garden was established by West African Rice Development Association (WARDA); with up to 60 rice Varieties, including local/traditional, improved and inter specific varieties. After the site's selection, men and women rice farmers were invited to visit the plot as frequently as possible (Spencer *et al*., 2006).

During the three visits at different stages of production in the first year, varietal selections were recorded for each farmer and at the end of the season each farmer's choices were analyzed. Based on the analysis, each farmer received in the second year up to 6 of the varieties she/he selected in the first year. At the end of the second year, farmer's evaluations of the ease of threshing and taste were elicited to provide a full view of the variety's strengths and weaknesses. In addition, they were asked to purchase any additional seed they required in the third year to provide an indication of their willingness to pay for seed of the new variety. During the third year, activities included the supply of small quantities of seed to local communities and seed companies for multiplication, publicity and training. By 2002, a full set of upland PVS trials were conducted in 11 States of the Federation. Following this, independent evaluation of top varieties that had shown adaptability and acceptability across the country was carried out by the National Rice/Maize Centre of the Federal Ministry of Agriculture. For this exercise, five varieties5 were evaluated in 21 States. Based on the results of this national field evaluation, the Ministry of Agriculture and the Centre recommended the official release of three varieties to farmers in 2003. By 2004, WARDA upland rice variety

dissemination work under the Gatsby Foundation project therefore covered a total of 21 most important rice growing states in Nigeria. NERICA 1 was officially released in 2003 and NERICA 2 in 2005. Two major initiatives were undertaken after 2003 to accelerate the dissemination of NERICA in Nigeria. The first was the Presidential Initiative on increased Rice Production, Processing and Export launched in 2003 by the Federal Government of Nigeria. The second was the Multinational NERICA Dissemination Project (MNDP) funded by African Development Project (Spencer *et al.*, 2006). The African Rice initiative (ARI) which started in 2005 a total of 328 NERI-Boxes7 capable of planting 82 hectare were distributed to rice farmers' groups in all participating states. Periodic monitoring visits were jointly undertaken by the Project Coordination Unit (PCU), the National Agricultural Seed Council (NASC), the National Cereals Research Institute (NCRI) and officials of the Rice Farmers Association of Nigeria (RIFAN) to guide the participating states on sound seed multiplication techniques, such as the maintenance of adequate isolation distance, rouging of off-types and good crop husbandry. Also, 71 rice farmers' groups were formed involving a total of 657 farmers, including 259 women farmers (FMARD, 2006). In terms of seed quality control, NCRI was involved in training the Agricultural Development Programmes (ADPs) staffs on seed production techniques that assure good NERICA seed quality production. Furthermore, several farmers' field days around the NERICA seed multiplication plots were organized at the states level. These were used to create informal contacts and learning for accelerated multiplier effect among farmers (FMARD, 2006).

However, it should be noted that despite these major initiatives to push NERICA adoption in Nigeria, many states were not covered by the PVS trials and the NERICA

dissemination activities. Moreover, in states covered, only very few villages were involved in the trials and the project activities. However, farmer-to-farmer dissemination of NERICA varieties has occurred in many of the villages not covered by the PVS trials and other project activities. Since its introduction many studies have been carried out to assess NERICA in Nigeria and elsewhere in Africa. Somado *et al*., (2008) reported that under farmer conditions, where minimal inputs are applied, the NERICA varieties have raised the yields of upland rice by more than 50%. Specifically, NERICA varieties yield more than 1.5 metric tonnes per ha. The potential yield under farmers' conditions is more than 5.7 metric tonnes per ha, where fertilizer and other inputs are applied. Empirical studies carried out both in Nigeria and other countries in Africa have shown that NERICA adoption has positive impact on yield, income and poverty (Diagne, 2006; Adekambi *et al*., 2007; Kijima *et al*., 2008; Dontsop Nguezet *et al*., 2011).

The outcome of 2008/2009 African Rice Initiative Steering Committee/Experts surveyed showed that rice activities in three rice ecologies in Nigeria where NERICA dissemination activities were being conducted for rain fed upland, rain fed lowland and irrigated rice production. A total number of 48 villages were selected. These included villages where NERICA varieties had been introduced (called "NERICA villages") and the neighboring villages (5 to 15 kilometers away) where they were yet to be introduced. The survey was carried out at two levels. At the village level, focus group discussions were conducted with selected farmers and the village head to obtain prior information about the village in terms of its history, varieties grown, the state of infrastructure, constraints faced by rice farmers, and farm characteristics.

Accordingly, a second phase which targeted individual farmers thereafter were initiated an average of 7 farmers were selected from each village and 20 farmers respectably based on probability, in proportion to the number of rice farmers in the area. The total sample consisted of 500 farmers. Data on their socio/demographic characteristics, knowledge, access to seed, and adoption of NERICA, farm size, and returns were collected. Evidence reveals that among 93.1% of the respondents who adopted NERICA varieties, 90% were male. At the time of the survey, the average age of the farmers was 47 years. The average household size among respondents (both adopters and non-adopters) was 10. 80% of respondents were natives of their respective villages and have spent on average about 42 years in their villages. 84.8% of the respondents stated agriculture as their major occupation, have an average cultivated land area of 2.91 ha, and are aware of an average of 1.6 improved varieties of rice. About 30.7% of farmers were aware of at least one NERICA variety while 25.5% of them have access to its seed. It should be noted that all the adopters 100% were both aware of, and have access to seed of NERICA varieties. This is because one cannot adopt a technology without being aware of, and have access to that technology. Only 4.9% of the total sample has access to credit. The majority of both adopters 52.2% and non-adopters 57.4% have access to Information Communication Technology (ICT). Respondents walk an average of 4.3 km to reach the nearest seed market according to another report by Adekoya and Ajayi (2000).

The educational level of the heads of households is significantly different between adopters and non-adopters. About 69.1% of the adopters had at least primary school level education compared to 42.8% for non-adopters. There is also a significant difference between adopters and non-adopters in the attendance of vocational training,

as well as in the type of experience in rice farming. Data on a set of institutional characteristics that is the percentage of farmers with access to extension services provided by NCRI and Agricultural Development Projects (ADPs) was also collected. This revealed that 12.7% and 8.5% of NERICA adopters and non-adopters had contact with NCRI and ADPs. The test of difference between the socioeconomics/demographic characteristics of both adopters and non-adopters reveals that the two groups are significantly different from one to another that is they are heterogeneous. This expresses the presence of selectivity bias (Dibba *et al.*, 2008a and Dibba, 2010).

Diagne (2010) work shows that the Average Treatment Effect, (ATE) framework is use for the estimation of adoption rates and their determinants. Estimation of determinants of awareness and awareness-access to seed of NERICA varieties, showing that the two models were well fitted. Education, contact with extension agents, years of residence in the village, major occupation, vocational training, age of the farmer, number of local varieties known by the farmers and distance to the nearest market were statistically significant at different levels in explaining the two major constraints to adoption (awareness and access to seed of NERICA varieties) (Adekambi, Kinkingninhou-medagbe and Biaou, 2009). Farmers with secondary level education tend to be more aware and have both awareness and access to NERICA varieties seed than those having only primary and no formal education. In addition, elderly farmers and those who know many local varieties have a higher probability of being aware and have both awareness and access to NERICA varieties seed than younger farmers and those who know only few local varieties. Farmers that have agriculture as their primary occupation or have received a vocational training in agriculture are more likely to be aware of, and have both awareness and access to seed of NERICA varieties than those that have agriculture

as a secondary activity or do not have any vocational training. This can be explained by the fact that the typical farmer spends almost all his working time on farm activities. This increases his/ her access to some information and, in some cases, increases his/her number of contacts with the extension services. The number of years spent by a farmer in the village negatively affects the probability of farmers being aware of, and having both awareness and access to seed of NERICA varieties. This means that the longer a farmer stays in the village, the less likely she/he can be aware of, and have both awareness and access to seed of NERICA varieties. Indeed, one more year spent in the village reduces the probability of awareness and have both awareness and access to seed of NERICA varieties respectively. This can be explained by the fact when a farmer spent more year in a village she/he is aware of many local and others improved varieties which can make she/he not to be aware or not to have both awareness and access to NERICA seed. Distance to nearest inputs market tends to reduce the probability of his/her being aware of new varieties, and consequently reduces the probability of having access to their seed. The marginal effect shows that distance to nearest inputs market is significantly inelastic to their probability to have both awareness and access to seed. Specifically, an increase in distance by one kilometer leads to only 0.004% decrease in the probability of having awareness and access to NERICA's seed (Adekoya and Ajayi, 2000).

Appleton and Simon (2001) show that the results of the ATE estimation of the different NERICA population awareness, access to seed, and adoption rates and gaps are presented in the sub-population of the aware; all the parameters estimated were significant at 1% level. The sample awareness rate of NERICA among rice farmers in Nigeria was estimated to be 30.1% while the estimate of access to seed was 25.5% in

2008. These figures reveal that not all the rice farmers who knew about NERICA varieties in 2008 have access to its seed. The joint awareness-access and adoption (JEAA) rate was 18.9%.

However, as demonstrated by Diagne (2010), the relatively incomplete diffusion of NERICA varieties and the relatively low level of awareness-access to NERICA seed in the country, the estimated joint awareness and adoption and joint awareness access to seed and adoption rates significantly understate the population adoption rate as of 2008. The estimated population adoption rate of NERICA (ATE), indicates the demand for NERICA varieties among the target population, was 54.4% with awareness unconstrained and 62.3% with awareness-access-unconstrained, which is the true population potential demand. This shows a potential adoption gap of 7.9%. This means that if the entire population of rice farmers were aware of NERICA varieties in 2008, the potential demand would have been 54.4%. If, in addition to being aware, all the farmers had access to seed of NERICA varieties, the potential demand would have been 62.3%. The 7.9% gap can, therefore, be interpreted as the access to seed gap which is the potential demand loss due to non-access to seed. The estimated adoption rate within the awareness-unconstrained sub-population was 62.3% compared to 75.3% among the sub-population with awareness-access-unconstrained (ATTs).

He further added that the gap of 13% between the two rates may be explained by the fact that the sub-population N of farmers who are aware and have access to seed is included in the sub-population of farmers who are aware of the variety. The (potential) adoption rates among the sub-population of farmers who are not exposed (ATUw) and have no access to seed (ATUs) of NERICA varieties were 50.9% and 58.0% respectively. The

corresponding estimates of the NERICA population adoption gap (the non-exposure bias (GAPw) and the access to seed bias (GAPs)) are -35.5% and - 43.4% respectively. These adoption gap estimates imply that there is still a potential for significantly increasing NERICA adoption rates in Nigeria. The estimated population selection bias (PSB) was 7.9% for the aware and 13% for the aware and access to seed sub-populations. The PSB estimate was not statistically significant for the aware subpopulation.

Spencer *et al*. (2006), Nigeria in a comparative study with Côte d'Ivoire, smaller than the 30% and 40% reported for Ekiti and Kaduna states of Nigeria respectively He used the sample adoption rate and assumed full awareness and full access to seed of NERICA varieties by the farmers, Compared across ecologies and states, shows that the incidence of these parameters was high in the upland ecology 78.4% for the potential adoption rate, follow by irrigated ecology 61.9% and 55.2% in the lowland ecology. Similarly, Osun State has the highest potential 67.0% followed by Kano 60.1% and Niger 49.8% states. These statistics show that the upland ecology has the highest potential in terms of NERICA adoption. These results were expected since the first NERICA varieties developed and disseminated were more suitable for the upland ecology than any others ecology (Jones *et al*., 1997). NERICA adoption among rice farmers in Nigeria, It is necessary to note that in practical estimation terms, the main difference between the ATE parametric adoption model and the "classic" adoption model lies in the fact that the "classic" model uses all the sample observations while the ATE parametric uses observations from the awareness-unconstrained or awareness-access-unconstrained subsample only. These two models point out differences in the magnitude of the

coefficients, as well as their marginal effects. These were significant at 1 per cent level each showing that the models were well fitted (Diagne, 2006 and 2010).

The probability of adopting NERICA varieties increases significantly with farmers who have contact with extension services, have received a vocational training or have more than primary school education level. More years of education and/or experience and increase in contact with extension officers are often hypothesized to increase the probability of adoption. This is because of factors inherent in the aging process or the lowered likelihood of payoff from a shortened planning horizon over which accepted benefits can accrue (Fernandez-Cornejo *et al*., 1994; Barry et al., 1995; Batte and Johnson, 1993). Another reason is that in agriculture, technological innovations are perceived to be more risky than in other traditional practices. Some researchers have argued that the perception of increased risk inhibits adoption (Feder *et al*., 1985). When an innovation first appears, potential users are generally uncertain of its effectiveness and tend to view its use as experimental (Mansfield, 1966). Hiebert (1974) and Feder and Omara (1981, 1982); show that uncertainty declines with learning and experience, thus inducing more risk-averse farmers to adopt an innovation, provided it is profitable. Similar results were reported by previous studies on improved technology adoption (Gockowski *et al*, 2004, Shiferaw *et al*., 2006). Regular contacts with the extension service make farmers aware of new technologies and improve their knowledge on how they can be applied. NERICA as its increase by one year leads to increase in the probability of adoption by 0.01. Many years in the village helps the farmers to have a good knowledge of the major production aspects and systems that can be practiced in the village; to have a sound knowledge of agronomic practices and to locate the major sources of production inputs such as seed, fertilizer and even land at affordable price.

Finally, respondents that have agriculture as their major occupation tend to adopt NERICA more than those who use agriculture as secondary occupation. Although some of these variables are not significant, their signs are nevertheless in line with findings of previous studies (Saka *et al*., 2005, Okoedo-Okojie *et al*. 2009, Odoemenen and Obinne, 2010 and Namwata *et al*., 2010).

2.3 Factors Influencing Adoption of NERICA Rice Agronomic Practices

Diffusion and adoption research on agricultural innovation started over half of the century ago, mostly in USA by rural sociologists. They focused their research efforts mostly on the relationship which exist between farmer's personal characteristics and their farming methods and practices. According to Rogers and Shoemaker (1971) most of the early diffusion and adoption studies in developing countries were conducted in Columbia, Brazil, Pakistan India and Nigeria in the early 1960. Earliest diffusion and adoption studies in Nigeria were conducted between 1964 and 1966 (Rogers, 1983). This study found positive relationship between socio-economic development of a villager's degree of communication integration, change agent contact, individual characteristic and the success of village programmes in agricultural change. Adoption is the decision to make full and continuous utilization of new technology, idea or innovation. In other word, it is a larger scale of continuous use of a new technology, idea or innovation until something new or superior comes out. Adoption facilitate when farmers have access to factors like extension service, credit facilities, farm inputs and other technological innovation, considered the factors associated with adoption into adopter characteristics, social system variables and innovation attributes, the adoption process is essentially a decision-making process (Ekong, 2003).

Research studies in the United States of America particularly, have identified a number of stages in the process of adoption. While different researchers tend to claim different number of stages, the North Central Rural Sociology Committee has accepted five stages including awareness, interest, evaluation, trial and adoption-(Rogers, 1983). He also claimed that in Nigeria these stages can be reducing into three-awareness, trial and adoption. The length of time required between awareness of innovation and its final adoption is known as the adoption period. It has been found that this period varies from one innovation to another depending upon the characteristics of the innovation, and also from one culture to another. Some farmers may not ever adopt a particular innovation simply because it is not applicable to their farming practices or for other reasons.

Speaks of "a maximum adoption year" which he defines as the year when the highest number of farmers adopts a particular innovation throughout the life of such innovation. According to his study of the adoption of poultry farming among farmers in Ondo State of Nigeria, this peak year did not occur until ten years after farmers in that area started adopting poultry farming. Individuals adopt innovation at different rates. While some are always on the lookout for new things others only accept innovation after much persuasion and when everyone else might have adopted that innovation. Thus researchers have classified individuals according to their innovativeness. Various terms have been used in such classification, but the North Central Rural Sociology Committee has accepted the following standardized categories- 'innovations', 'Community adoption leaders', 'Local adoption leaders' and 'Later adopters' – based on a decreasing order of innovativeness. Rogers has however described five categories of adopters purely as ideal types maintaining that there are no pronounced "break" in the innovativeness continuum among each of the five categories.

Researchers look at the characteristics of the innovations themselves. What they found was that the new technologies had to demonstrate a clear relative advantage over the old practices. So for example, when new hybrid corn variety produced yields that were 20% better, farmers quickly noticed and adopted the new ideas. The new varieties were also still corn-in other words, the plants were not radically different. They could still be planted, cultivated and harvested with equipment that farmers had. That was the second characteristics of a successful innovation; it has to be consistent with existing cultural patterns (Ekong, 2003).

According to Ekon, (2003) the characteristic of innovation and their effect on adoption and non-adoption of improve agricultural practices found that complexity of the innovation was associated with change of existing practice. Examine the reason behind low rate of adoption of improved technologies in Northern Nigeria the result show's that low rates of adoption observe did not reflect innate of undesirable psychological characteristics of small farmers. It is indicated that the specific characteristics of innovation will be discus mainly in three perspectives. These are;

Physical characteristics of innovation: Physical characters of an innovation are usually of three (3) components which described its nature, handling and management. The components are observed in terms of how the prospective adopter can easily grapple with it, that is, understanding and cope with the situation. Material (hardware) component: refers to the hardware or physical appearance (physical nature, packaging). Secondly Service component: this refers to the skill required to operate the innovation and how this can be imparted. Thirdly Software component: the application instruction, knowledge and attitude required.

The components are usually rated in order of complexity and this determines the order in which they are introduced in the course of diffusion. It is a common practice to introduce the simplest component first although this also depends on certain capacities of the target audience like education, previous experience, for example, if machines like tractors are to be introduced, the material component will be consider the most complex because the target will not be able to understand this but it will still be introduced first since this essentially is what they only need in adopting it as other component are to be handle by them professionals like mechanics. However, when the users have grapple with the three components, the simplest component is introduced first example fertilizer use where the software is first.

Innovation characteristics influencing adopters: There are characteristics of the innovation which the prospective adopter considers and serve to bolster decision to adopt.

Relative advantage: This is the degree to which an innovation is perceived by the farmer as better than the one the farmer is presently using. This may be measured in terms profitability, low cost, time saving and immediacy of reward. It may even be in terms of socio-prestige factors, convenience and satisfaction. What really matters in this case is the perception of advantage as perceived by the adopter.

Compatibility: This is the degree to which an innovation is perceived as consistent with the existing values, beliefs, past experiences, and needs of potential adopters. For instance, the use of farm yard manure by farmers in Okura-Olafia area of Igala Land of Kogi State is taboo and therefore not compatible with the existing values of the people

in these communities because they cannot imagine the use of farm yard manure as a source of nutrient to the crops which they have to consume. The introduction of piggery in a Muslim community is not practicable (Ekon, 2003).

Complexity: This is the degree to which an innovation is perceived as relatively difficult to understand and use. This may also be defined as the degree to which the adopter or potential adopter finds the innovation easy to manipulate. When innovation builds upon existing practices and skills the skill required are completely new and the knowledge somewhat abstract, then it appears complex. Simple ideas/innovation may likely to be adopted more readily than complex.

Triability: This is the degree to which an innovation may be experimented with on a small or limited basis. The use of improved seed, fertilizer and herbicides can be tried on a small plot on the farmer's field without risking the entire harvest by using the innovation on the whole farm.

Divisibility: This the degree to which an innovation may be experimented within small unit. Since innovation hold a degree of uncertainty, adopters usually consider the risk factor. Thus innovations are considered with a measure of uncertainty, implying the need to try it out rather in bits. For example, small quantity of improve seeds, fertilizer or herbicides could be purchased and used. However, this is not possible with purchase of tractor or sprayer which is a onetime major investment and therefore not divisible. Part of it cannot be bought and used or tried in phases though they could be hired Divisibility should be confused with triability.

Observation: This is the degree to which the result of an innovation is visible and could be discussed with other follower farmers. This is a reinforcement issue in diffusion and which helps adoption decision. The effect of application of fertilizer to a maize plot can easily be noticeable and convincing to any farmer not used to the use of fertilizer on maize.

Accessibility: This is the degree to which an innovation is readily available and affordable with minimum effort. There is little need for a change agent to push farming inputs that the farmers either cannot afford or for which the infrastructure does not exist for its distribution. Adoption process occurs over period of times and consists of a series of stages (Roggers and Shoemakers, 1971) the number of stages involved in the adoption process as reported by researchers has been varied, however, the five stage model has been the widely accepted. These stages are: the awareness stage, the interest stage, evaluation stage, trial or implementation stage and adoption stage.

2.4 Effects of Adoption of NERICA Rice Agronomic Practices on Yield, Income and Farmers Level of Living

Agriculture is the economic mainstay of the majority of households in Nigeria, and is a significant sector in Nigeria's economy. The important benefits of the agricultural sector to Nigeria's economy include: the provision of food, contribution to the gross domestic product (GDP), provision of employment, provision of raw materials for agro-allied industries, and generation of foreign earnings labour (until the early 1970s; agricultural exports were the main source of foreign exchange earnings) (CBN, 2006).

A sectoral analysis in 2006 of the real GDP indicated that the agricultural sector contributed to about 42% of the GDP compared with 41.2% in 2005 (CBN, 2006). The

growth rate of the contribution of the agricultural sector to the GDP at 1990 constant basic prices grew from 4.2% in 2002 to 7.2% in 2006. The agricultural sector also employed over 60% of the total labour force in Nigeria in 1999 (Adeoti, 2002). The advent of oil in the early 1970s made Nigeria highly dependent on oil revenue, with the performance of the agricultural sector adversely affected over years. Adeoti (2002) said, though the growth rate in the agricultural sector in Nigeria increased from an average of about 3% in the 1990s to about 7% in mid 2000, the food security/sufficiency status of Nigerians continued to decline.

The dismal performance of the agricultural sector in terms of its contribution to Nigeria's yearly total revenue in the last three decades prompted the government to initiate several agricultural schemes and programs to enhance agricultural productivity in Nigeria, which include the following: the River Basin Development Authorities, the National Accelerated Food Production Project, the Agricultural Development Project, Operation Feed the Nation, the Green Revolution, the National Directorate of Food, Roads and Rural Infrastructure, the Agricultural Credit Guarantee Scheme Fund, the National Special Programme for Food Security, Root and Tuber Expansion Project, and the National Fadama I and II program. Similarly, a series of studies have been carried out to assess agricultural productivity and its drivers in Nigeria, which include: Adebayo (2006), Adeoti (2002), Ajani (2002), Ajibefun et al. (1996), Awotide (2004), Ogundele (2003), Ogundele and Okoruwa (2006), Okike (2000), Oredipe (1998). None of the aforementioned studies, however, has assessed productivity within the context of agro-ecological zones.

Despite Africa's potentially rich land, water resources and extension services as well as series of research on different agricultural production sectors, its farmers are among the poorest in the world. Because the vast majority of people in Africa derive their livelihoods from agriculture, the weak state of the sector has profound implications for persistent food shortage and the deteriorating poverty incidence in Sub-Sahara Africa (SSA), are major development issues (Sarkar, 1998). Agricultural innovation in Africa needs to internalize the region's biophysical, institutional, and socioeconomic constraints and establish efficient value chains to support sustainable growth and reduce poverty. New Rice for Africa (NERICA) was developed to boost the rice yield and income of rural households in SSA. Although its high yielding traits have become fairly well known, there is no empirical analysis of its impact on income and poverty. By taking the case of Uganda where a NERICA promoting program was initiated as one of the major poverty eradication measures, (Kijima, Keijiro and Dick 2007).

Kijima *et al*. (2006) study attempts to compare actual income with the hypothetical income without NERICA. This study has found out that on average shift from maize to NERICA with proper crop rotation increases income by USD 250 per hectare. Moreover, introduction of NERICA decreases poverty to a significant extent without deteriorating income distribution. Recently, the Ugandan government has introduced New Rice for Africa (NERICA), a high-yielding upland rice variety suited to the African environment, as one of its poverty eradication strategies. NERICA can serve both as a cash crop and a subsistent food crop in Uganda. Even though most farmers in Uganda currently grow NERICA without fertilizer, its average yield is more than twice as high as the average upland rice yield in SSA at 2.3 ton per hectare. As with the Green

Revolution in Asia, NERICA is expected to boost rice production and income for rural Ugandan households.

A critical question at present concerns the extent to which NERICA has contributed to poverty reduction and affected income distribution in rural Uganda. In order to answer these questions, it is critically important to examine the effect of NERICA adoption on labour demand, as the poor tend to depend on such income. It is also important to identify the determinants of NERICA adoption, as new technology may particularly favor educated, wealthy farmers. The study examines the effect of NERICA on poverty reduction and income distribution by using household survey data collected in 2005 in 10 NERICA growing areas in rural areas in Central and Western Uganda. It is important to emphasize here that in most of the sampled areas, NERICA is the first upland rice variety ever introduced. In most areas, many households have increased the total cultivated area by converting fallowed land into NERICA fields to avoid reducing the size of land planted to traditional subsistence crops such as beans, maize, and cooking banana (Matoke). In a few sample areas, however, NERICA has replaced traditional crops. In Hoima district, for example, the plots planted to tobacco in the first cropping season were usually planted to maize, millet, and upland rice varieties other than NERICA in the second cropping season. Currently, however, farmers often plant NERICA after tobacco. The reason why farmers left some land uncultivated before NERICA was introduced is because opening land is a very strenuous task. Unless the returns are expected to be high, households do not have incentives to extend the cultivated land.

The major upland rice growing areas are located in northern Uganda. Since the Northern part of Uganda has been socially and politically unstable, we could not conduct out survey in these areas. The impact of NERICA varieties adoption on household income and poverty, are also documented in few studies which find generally NERICA to increase household income and to contribute to better income distribution within African rice growers households. The analysis of impact on income and poverty showed that in Uganda, NERICA has the potential to increase per capita income by 20 USD (12% of actual per capita income) and to decrease the poverty incidence, measured by the head count ratio, by 5% points from 54.3% to 49.1% (Kijima et al 2008). This authors also found that, not only the head count ratios but also poverty gap index and squared poverty gap index decline by the introduction of NERICA, suggesting that its income enhancement can be realized among the poorest of the poor in this country of Eastern Africa. In West-Africa, Glove (2009), Dibba *et al.*, (2010) and Dibba (2010) finds NERICA adoption to have positive impact on household rice and total incomes in Gambia.

In particular, Dibba (2010) found that adoption of NERICA increases the rice farmer's daily income by about 10 Dalasi approximately 0.34 USD on average. For Benin, the poor is defined using of the income poverty line of CFA 51,413 per year in rural areas and CFA 91,709 per year in urban areas (Sogbossi, 2008). The research further discovered NERICA adoption as a key determinant in poverty reduction and found that NERICA adoption contributed at 13% decrease in the probability of being poor. In addition, the gender-based analysis demonstrated that the impact of NERICA adoption is higher on women farmer (reduction of probability of being poor is 19%) than men (reduction of probability of being poor is 6%). Findings from another study conducted in

Nigeria indicated that the incidence of poverty was higher among non-NERICA adopters 50.2% than NERICA adopters 45.5%. In addition, both the depth and severity of poverty were also higher 19.25% and 10.02% among non-adopters than the adopters 15.28% and 7.76%. Adoption of NERICA increased total farm household income and per capita expenditures by respectively N63, 771.94 approximately 554.5 USD and ₦4, 739.96 approximately 41.2 USD thereby increasing their probability of escaping poverty (Dontsop *et al.*, 2010). These results on impact of NERICA adoption in Africa reviewed above seem to confirm that NERICA can bring hope for millions of small-scaled poor farmers in the continent by 14 reducing poverty and income inequality within population. But the realization of such hope is conditioned by its wider dissemination which can only take place if the seed bottlenecks and other production constraints mentioned in the lessons learned in the next section are addressed.

2.5 Constraints Farmers Encountered in Adoption of NERICA rice Agronomic Practices

New rice for Africa NERICA as a new crop in the farming system, inadequate knowledge in activities pertaining to NERICA farming enterprise was reported as the most severe constraint facing rice farmers. This may be attributed to the significant amount of herbicides and pesticide use; post-harvest handling, processing and marketing; pests, diseases and soil fertility management; irrigation and water harvesting skills required of farmers. The inadequate knowledge in post-harvest handling and processing is directly affecting rice processing at the mills. All the rice processors interviewed reported that one of their biggest problems is the supply of low quality paddy by farmers: either wet, over dried or contaminated with foreign matter especially

stones. The poor quality paddy results into low quality milled rice thus difficult to market (Kenmore, 2003).

Farmers cited the issue of poor quality and expensive seed among the priority constraints. During the study 60.9% of farmers interviews reported that some seed companies sell seed: of mixed varieties, whose manufacturing date is not shown, whose variety name is not indicated on the package and that has low germination percentage. Analysis of constraints from individual farm household interviews indicated that 60.9% of the farmers in the 6 surveyed districts obtain rice seed which is expensive and yet of poor quality. The situation was worst observed in Lira and Kamwenge districts (Anon, 2005).

Appleton and Simon (2001) indicated that strenuous and labourious rice farming operations was reported as the second most severe constraint inhibiting expansion of rice production. Ploughing, planting, weeding, harvesting, threshing and transportation were cited as the most strenuous and labourious operations. Women, who are the main labour providers in farming, reported planting, weeding and harvesting as their biggest labour constraint areas in rice farming. According to farmers the situation is aggravated by lack of appropriate rice farming tools, implements and equipment. Besides, the equipment available is often too expensive for the average farmer. Most farmers depend on rudimentary, labour and time consuming hand tools such as hoes, slashers, sickles, axe, for various farm operations. As a coping strategy, farmers in districts like Lira and Kamwenge pool labour among themselves and work in members' fields in turns. In a number of districts children are forced to miss classes to contribute to household labour. Most farmers are however forced to open small size rice plots (1 -2 acres) that are within

their family labour capacity. Most farmers reported “working extra hours” as the main copying strategy towards the labour problem, however at the expense of their health.

Lack of capital is one among the priority constraints in rice farming. Capital is badly needed to purchase improved farm inputs (seed; farm tools, implements and equipment; pesticides and herbicides; and to hire labour and skilled trainers Agribusiness Development Centre (2001). Although ADC were reported micro-finance institutions operating in all the study area, guar anting very little opportunities existed for farmers access farm-credits through these institutions, hence the unfelt impact of credit in rice farming in all districts surveyed. Most farmers reported that the policies, interest rates and other terms that most financial institutions attach to agricultural loans do not favor farmers. The ADC survey noted that though some of the farmers were very anxious in getting agricultural loans, majority neither had a demonstrated saving culture nor training on the management of loans. In a number of cases farmers actually feared getting any loans, citing the normally serious consequences in case of failure to repay the loan. It must however, be appreciated that lending institutions are in the business of making money through “lending and recovery”. In cases where a significant degree of uncertainty exists on possibilities of failure to recover such loans, the lending institution has course to fear, (ADC, 2001).

High crop damage and loss caused by rice pests was reported as one of the constraints affecting rice farming. The most dangerous pest identified was birds and if not attended to, they can cause up to 100% loss in yield. The bird problem was cited in all districts surveyed. Farmers coping strategies include physical scaring off of birds or using scare crows. School children are often stopped from going to school (Mugisha, 2002).

Harvest of improperly dried paddy by farmers (either wet or over-dried), Majority of the farmers don't know when to harvest and how to properly and effectively dry paddy. Some farmers harvest rice when it is premature (Kenmore, 2003). The premature rice has poor quality when milled, it looks like white chalk. Other farmers after harvest cover the wet paddy before drying thus causing it to partial mould. The wet or over dried paddy causes high breakages during milling. 29% of rice millers reported that some farmers bring paddy which is contaminated with foreign matter especially stones. The stones and other foreign matter increase the rate of ware on the rollers and often destroy mill-sieves. Lack of paddy all year round was reported as some of the constraints rice millers are experiencing. Due to inadequate paddy, 75% of millers do not operate their mills all year round. Majority of the mills are therefore underutilized, which represents uneconomical use (Oryoko, Farster, Kayayo and Pookat 2004).

2.6 Theoretical Framework

The theoretical framework adopted in this study is the adoption and diffusion theory which fall under the breeds social change and modernization theories modernization theory. According to this approach, economic development involves the transformation of the social structure which permits the proliferation of innovation and technologies that would make impacts (Musa, 2006). The modernization theory sees development in terms of displacement of traditional or primitive's values by modernity through adoption and diffusion's process.

2.6.1 Adoption and Diffusion Theory

Rogers (1962) indicated that diffusion of innovations theory is a theory that seeks to explain how, why and at what rate new ideas and technologies spread through cultures.

He also said Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. The origins of the diffusion of innovation theory are varied and span multiple disciplines. Diffusion is the process by which an innovation spread from the source of its invention to the ultimate users or adopters. Whereas adoption process deals with adoption of a new idea by an individual, diffusion process deals with the spread of new ideas in a social system or the spread of innovations between social systems or societies (Rogers, 1995). The segments of the social system in a study area under reference can influence individual farmers to display varying degrees of innovativeness from innovators to laggards. Opinion leaders who are generally early adopters enhanced diffusion of innovations, while late majorities and laggards hinder it.

Adoption – diffusion theory was the dominant approach in 1960s (Rogers, 1995). Diffusion theorists accepted the products of agricultural research as wholly desirable. Hence, their work focused almost exclusively on the fate of innovations designed for farm use. They employed a communications' model adopted from engineering in which message were seen to be transmitted from sender to receiver, later adding the engineering them "feedback" to describe the receivers responses to the message sent to them. They argued that adoption could best understand as base on the psychosocial characteristics of adopters and non-adopters. Early adopters were found to be more cosmopolitan better educated less risk averse, and more willing to invest in new technologies than late adopters, pejorative labeled 'laggards.

2.6.2 Conceptual model

Asiaka, (2001) viewed model as a construction that shows relations existing among variables. These relationships are depicted schematically or mathematically were concept is a corm firmed idea about a phenomenon and model is a general conception of a phenomenon example rural society a phenomenon consists of anything human being live or experience so it is the study of live (Haralambos and Holborn, 2008). Models have been used in research as primary tools for organizing knowledge gained in experimentation (Adebayo and Okunaye, 2004). A model is a figurative expression of relationships. The basic assumption in this study is that farmer's socio-economics characteristics, institutional and technological factors plays significant roles in influencing adoption of recommended NERICA production practices to bring about changes in the livelihood of the farmers Figure 2.1

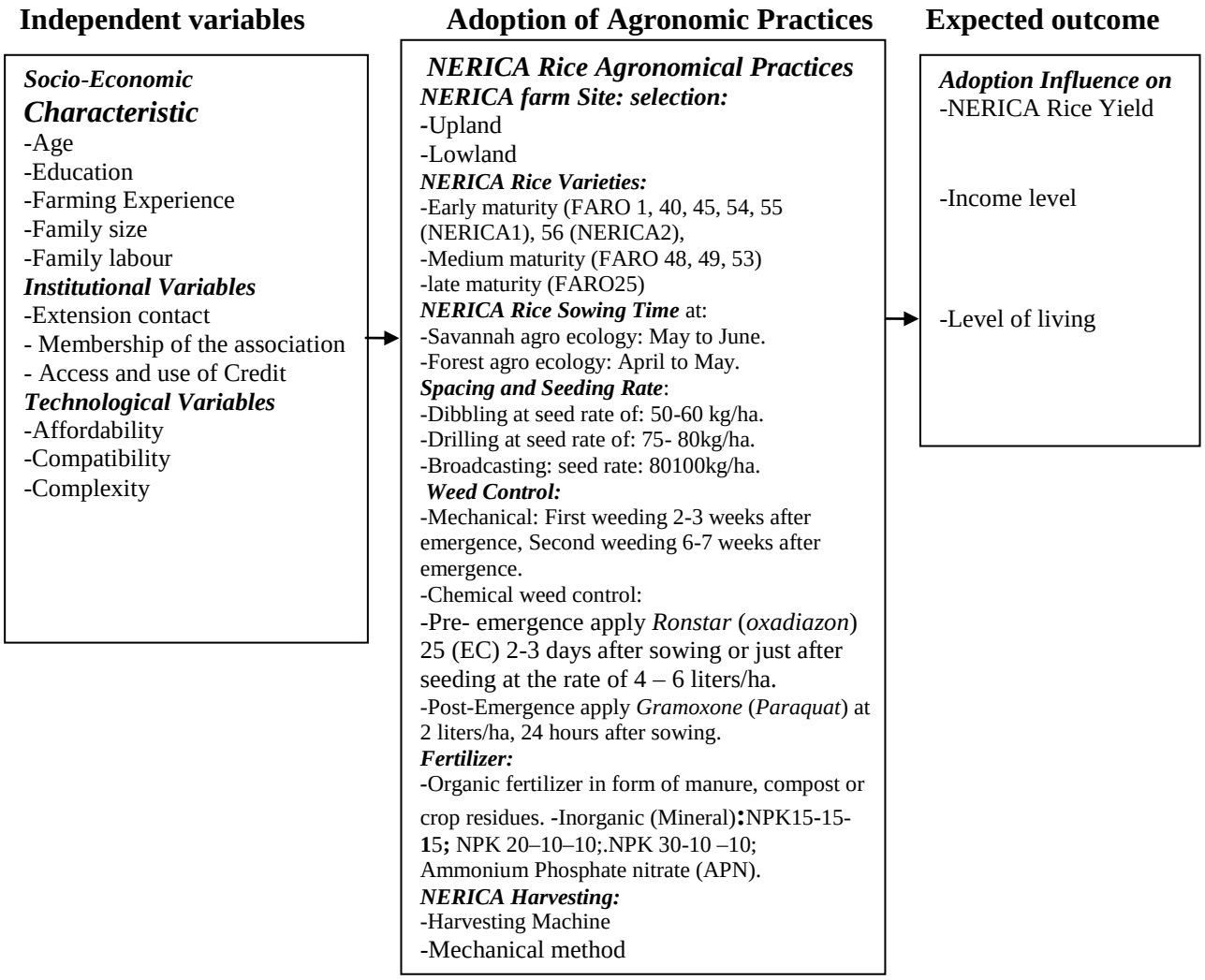


Fig. 2.1: A model showing factors influencing adoption of NERICA Rice agronomical practices and effects of adoption on yield, income and level of living.

CHAPTER THREE

METHODOLOGY

3.1 The study Area

Tudun Wada, Kura and Garun Malam are Local Government Areas (LGAs) in Kano State, Kura and Tudun Wada were created from Rano LGA in 1989 and 1976 respectively and Garun Malam was carved out from Kura LGA in 1996. The three LGAs are located in the south west of the state, between latitudes $11^{0}15^{1}$N and Longitudes 8^{0}25E. The area is Sudan and Guinea savannah vegetation, with annual rainfall of 600 - 1200mm. Mean annual temperatures ranges from 30-35^{o}C. Kura LGA has an area of 206 km² and a population of 144,601, projected to 174, 682 in 2014 using a growth rate of 3.2%. Garun Malam LGA total land area is 214 km² and a population of 116,494; projected to 140,728 in 2014 using a growth rate of 3.2%. Tudun Wada LGA has an area of 1,204 km² and a population of 231,742, projected to 279, 952 in 2014 (NPC 2006). The predominant ethnic groups in these LGAs are Hausa and Fulani. About 80% of the peoples are engaged in various forms of agricultural activities (http\\www.kanogovt.org.ng).

3.2 Sampling Procedures and Sample Size

A multistage sampling method was employed to sample 110 NERICA rice farmers. The first stage involved purposive selection of three LGAs with highest level of NERICA rice production in Kano State, namely Tudun wada, Garun Malam and Kura LGAs. In the second stage; purposive sampling procedure was used to select two (2) villages on the basis of being the most prominent NERICA rice producing areas, from each selected Local Government Area. These were Yaryasa and Nataala in Tudun Wada LGA, Chiromawa and Garin Babba in Garun Malam LGA, Karfi; Kura town in Kura LGA.

From these villages, a list of NERICA rice farmers was obtained from the Extension workers in charge of the LGAs. A total of 110 NERICA farmers were randomly selected at 20% of the total population as the sample size (Table 3.1).

Table 3.1: Sampling and Sample size

LGA	Villages	Number of Participating farmers	Sample (20%)
T/wada	Yaryasa	108	21
	Nataala	81	16
Kura	Kura Town	97	19
	Karfi	68	14
G/Malam	Chiromawa	79	17
	Garin-Baba	115	23
Total		**548**	**110**

3.3 Method of Data Collection

The primary data were obtained using structured questionnaire. The questionnaire was administered to the sampled households of NERICA rice farmers with the help of trained enumerators. The structured questionnaire was used for data collection on household socio-economic characteristics and the NERICA rice agronomic practices adopted by farmers. The farmers asked about their rate of adoption of NERICA rice agronomic practices, and the effects of adoption of NERICA rice agronomic practices on yield, income and level of living of the NERICA rice farmers in study areas. Relevant information from textbook, annual report from state Ministry of Agriculture and Natural Resources (MANR), State Agriculture Development Programs (ADPs) were the sources of the secondary information.

3.4 Tools for Data Analysis

The Combination of analytical techniques was employed for data analysis to achieve the objectives of the study. Descriptive statistics such as percentage, and frequency distributions were used to achieve objective i, ii, and v; and Multiple Regression Analysis was used to test hypothesis 1 and to achieve objective iii. Pearson's Product Moment Correlation (PPMC) analysis was used to achieve objective iv and to test the hypothesis ii, that stated that there is no significant relationship between adoption of NERICA agronomic practices and increased on yield, income and level of living of NERICA farmers.

The multiple regression models were explicitly specified as follows:

$$Yi = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} - b_{15}x_{15} + u$$

Where; Y = Adoption of NERICA agronomical practices (total number of NERICA agronomical practices adopted by the respondent):

Where: a = constant term and u = Error term

b_1 - b_{15} = Regression Coefficients of x_1 - x_{15} to be estimated.

X_1 = Age (in years)

X_2 = Level of education (Years in formal schooling)

X_3 = Experience (Years in NERICA production)

X_4 = Households Size (Numbers of people in the house hold)

X_5 = Labour (number of people hired for NERICA production)

X_6 = Farm Size (Hectare)

X_7 = Awareness Level (aware = 1, otherwise =0)

X_8 = Tenure status (the way NERICA farms land obtained, purchase, leased, inheretence)

X_9 = Extension contact (the total numbers of times farmers are visited by extension agent)

X_{10}= Membership of cooperatives (the numbers of cooperative societies/communities organizations the farmers belongs to 1, 2, 3, 4, 5, 6 and above)

X_{11} = Access to credit (amount in Naira received)

X_{13}= Affordability: 4 point Likert scale was used; (Very expensive, Expensive, Cheap, Very cheap)

X_{14}= Compatibility: 2 point Likert scale was used; (Yes =1 if compatible, No = 0 if Otherwise)

X_{15}= Complexity: 4 point Likert scale was used; (very difficult =4, difficult =3 simple = 2 and very simple = 1)

3.5 Operational Definition and Measurement of Variables

3.5.1 Measurement of independent variables

a) **Age (X_1):** This refers to the chronological age of the respondent as given at the time of data collection. It was measure as actual number of years given by the respondent as his age. The age scores were as follows: (20-39 years = 1, 40-49 years = 2 and 50 Years and above = 3).

b) **Household size (X_2):** This was measured in terms of number of people in a household living under the care of the respondent at the time of this study: the total number of the peoples under a household head was used as the score.

c) **Level of Education (X_3):** This refers to the numbers of years a respondent had spent in formal schooling.

d) **Farming Experience (X_4):** this was the number of years the respondent had spent in NERICA rice farming. The respondent was asked to indicate the years.

e) **Labour availability (X_5):** This was measured by sources of labour (family labour, co-operative labour, and hired labour) for the NERICA farmers.

f) **Total Farm Size (X_6):** This was the actual plot of land cultivated in one cropping season by the respondent. This was measured in hectares.

g) **Awareness Level (X_7):** The more innovations farmers are aware about, the more likely they will adopt it. A farmer was asked to mention the number of agronomical practices he was aware of. It was measured by the total number of agronomical Practices that the respondent was aware of.

h) **Tenure status (X_8):** This refers to the system of acquiring land. It was measured in term of pattern or processes by which a farmer acquired the land for NERICA rice production. The score were: purchase= 4, inheritance= 3, free gift = 2 and leasehold= 4.

i) **Access to credit (X_9):** This refers to the amount of money received in Naira from financial institutions or non-institutions for acquiring farm inputs for NERICA rice farming. This was measured in terms of amount received in Naira as credit by the respondent.

j) **Membership of cooperatives (X_{10}):** This refers to the social organization a farmer belongs to, that can make him/her more credible and influenced the attitude of members towards community development project. It was measured based on the number of cooperative a farmer belong to the score were 1, 2, 3, 4, 5, 6 and above and time spent in the score were 1-3 years 4-6 years 7-9 years 10 and above years.

k) **Extension contact (X_{11}):** The more numbers of visits of extension agent to the farmers the more likely they are to adopt innovations. It was measured by the total number of times a farmer had visits from the extension agent. The score are 1-3 times = 1, 4-6 time = 2, 7 and above = 3.

l) **Affordability (X_{12}):** This was measured by the use of 4 point Likert scale; Very Expensive = 4, expensive = 3, cheap = 2, very cheap = 1.

m) **Compatibility (X_{13}):** This was measured by degree of agreement on items related to compatibility using a 4 point rating scale (strongly dis-agree = 1, Dis-agree = 2, agree =3, strongly agree = 4).

n) **Complexity (X_{14}):** This was measured by used of 4 point rating scale (very difficult = 4, difficult = 3, Simple =2, Very Simple 1).

3.5.2 Measurement of dependent variable

The dependent variable is adoption.

Adoption: adoption in this study is the acceptance and continuous use of NERICA Rice Agronomic practices by the farmers. It was measured in terms of numbers of NERICA Rice agronomic practices adopted by farmers.

Effects*:* the effects were yield, income and level of living: yield was measured as the total kilogram of NERICA rice obtained by the farmer during 2012 cropping season divided by total hectares (kg/ha), income was measured as the total money realized from the sales of NERICA Rice in 2012 by the farmer within the season of the study. This was measured in Naira. Level of living was measured by the farmers possession of durable items such as zinc-house roofs, purchased of additional farm land, buses, trailer, animals such as donkey, work-bull and milking cow that are described as stock or capital. NERICA farmers were asked to estimate the price of each item purchased in Naira at the time of study if the item are to be sold in order to get a realistic monetary value of possessed durable items.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1.1 Socio-economic Characteristics of the Respondents

The major socio-economic characteristics of the farmers are presented in Table 4.1. The characteristics are sex, age, level of education and marital status, household size, extension contacts and farming experience.

Gender: It was found that there were 96% males and 4% females in NERICA production, indicating male domination in farming activities due to culture of female seclusion.

Marital status: The study found that 92% of the respondents were married, while 8% were single. The research shows that family labour was more available where the married couples were tended to worked together to achieve common goal. This is in line with Ekong (2003) who found out that married couple work collectively in any innovation adoption that involved activities from planting to harvesting and processing. Agbamu, (2006) discovered that married farmers adopted improved maize and cassava more than single farmers.

Age: The findings showed that 35% of the farmers were between 21-30 years old, 39% were between the ages of 31-40 years old while 26% were aged 41years and above. The study revealed that the mean age is 38 years. This is an advantage since they are supposed to be physically and mentally alert in learning and adoption of new innovations than the older farmers.

It was further discovered that middle aged had significant influence on decision making process of farmers with respect to risk aversion of adoption of improved agricultural innovation.

Level of Education: It was found that 40% of the respondents had secondary, 34% tertiary education and 8% primary education. This implies that 82% of the respondent had formal education, which contrasts with the findings of Sokoya (1997) who reported that 33% of the cassava farmers in Ogun State had no formal education. The finding is in consonance with Banmeke (1997), who discovered that majority (67%) of cassava farmers had formal education but at low level. It was found that the level of education determined the level of opportunities improved livelihood strategies, enhanced food security, and reduced the level of poverty. It influences the level of adoption and managerial capacity in production of the household members on how to adopt and integrate innovation into the household's survival strategies.

Table4.1: Distribution of the NERICA Rice Farmers by their Socio-economic Characteristics

Socio-economic characteristics	Frequency	Percentage (%)
Gender		
Male	105	95.5
Female	5	4.5
Total	**110**	**100**
Marital Status		
Married	101	91.8
Single	9	8.2
Total	**110**	**100**
Age		
21-25	4	4
26-30	35	31
31-35	20	19
36-40	22	20
41-45	11	10
46-50	10	9
51 and above	8	7
Mean = 38		
Total	**110**	**100**
Farmers Level of Education		
Non Formal Education	4	3.6
Adult Education	2	1.8
Koranic Education	13	11.8
Primary Education	10	9.1
Secondary Education	44	40
Tertiary Education	37	33.6
Total	**110**	**100**

Farming experience: It was found that 64% of the respondents had farming experience of 1-5 years; 23% of 6-10 years, and 6% of 11 years and above, in general the respondents had an average of 6 years of farming experience. Thus farmers with high farming experience were more likely to adopt more components of NERICA rice agronomics practices than those with low experience. With farming experience the respondents is expected to make sound decisions as regards resource allocations and adoption of NERICA agronomic practices which requires good management skills for optimum yield. The more the number of years of farming experience, the more the willing the farmers to adopt the NERICA rice agronomic practices.

Table 4.2: Distribution of Participant Farmers Based on Farming Experience

Farming Experience (years)	**Frequency**	**Percentage (%)**
1-5	69	62.7
6-10	25	22.7
11-15	3	2.7
16>	3	2.7
Total	**110**	**100**

Means = 5.72; Minimum = 1; Maximum = 25

Household Size: the study found out that 16.4% had 1-5 members 31% of the respondents had 6-10 and 11-15, 53% had more than 16 people as members of their households. The mean of family size was 15 people. This finding is contrary to the findings of Nweke (1989) who found that the average family size in Africa was 9 people per household.

Table 4.3: Distribution of the Respondents Based on their Household Size

Household size	Frequency	Percentage (%)
1-5	18	16.4
6-10	34	31
11-15	18	16.4
16-20	18	16.4
21 and above	22	20
Total	**110**	**100**

Mean = 15; Minimum = 1; Maximum = 61

4.1.2 Institutional Variable

Membership of Association: It was found that 82% of the respondents were belonged to association while 18% were not part of any association. Membership of social organization helps farmers to have access to farm inputs, loan and other resources that enhanced level of productivity. It was found out that highest number of farmers belonging to farmers' associations has gone into sensitizing and educating farmers about the benefits of being in farming groups, which is the basic of National Special Programme on Food Security (NSPFS's) philosophy.

Numbers of association belong to: the result shows that 73% of the respondent registered from 1-4 cooperative societies, 8% of the respondent reported their belonging to more than 5 social associations where 19% of respondent represented non participant or non-registered to any cooperative society. It was discovered that the average number of associations farmers belong to is 2.

Years of Membership of association: the result in Table 4.4 indicated that the average years spend in association is 4. The essential difference in numbers of years the NERICA rice farmer spend in cooperative society was influence adoption, before planting is largely dictated by the environment in which the rice was to be grown. Over

63% of the farmers spend 1-5 years in association while 19% reported that they spent more than 6 years long in the cooperative societies, while 19% of the respondent not been part of any association.

Table 4.4: Membership of Association, Number of Association and Years in Association

Membership of Association	**Frequency**	**Percentage (%)**
Yes	90	82
No	20	18
Total	**110**	**100**
Number of association belong to		
Non Respondent	20	18
1-4	81	74
5 and above	9	8
Mean = 2		
Total	**110**	**100**
Years of Membership of association		
Non Respondent	20	18
1-5	70	64
6-10	14	12
11 and above	6	6
Mean = 4		
Total	**110**	**100**

Mean number of association = 2.09; Minimum = 0; Maximum = 10

Mean years of membership in association = 3.94; Minimum = 0; Maximum = 20

Extension Contact: The result (Table 4.5) revealed that the mean extension contact is 8 while 23% of the farmers have no extension contact and 77% of the respondents were visited by extension agent, it was revealed that 42.4% of the respondent's visited extension agent 6-10 times, while 18%, 1-5 times and 40% visited extension agents more than 11 times, 93% were satisfied with extension visit and 7% were not satisfied, a

good contact between farmers and extension agent is one of the most important factors more likely to influence NERICA agronomic practices adoption. It is in line with Tamiyu *et al.,* (2009) findings which stated that Extension contact is very important determinant of technology adoption. A farmer whose contact with extension agents have very high expectation to be more familiar and more knowledgeable about the use of improved agricultural innovations. This variable is expected to be positively related to agricultural innovation adoption. The data on farmer's satisfaction with extension visit/contact illustrate that there is still tremendous potential to reach more farmers 71.82% of the respondent satisfied with extension visit/contact. The constraints to do so are numerous and vary from one survey area to another only 28.18% of the respondent are not satisfied with extension visit/contact. These interventions allow good interaction between farmers and extension agent as well as cordial relationship among farmers.

Table 4.5: Extension visit, Farmer Extension Contact and Farmers Satisfaction with visit

Extension Visit	**Frequency**	**Percentage**
Yes	85	77.3
No	25	22.7
Total	**110**	**100**
Farmers Extension Contact		
0	25	22.7
1-5	15	13.6
6-10	36	32.7
11-15	24	21.8
16>	10	9.1
Mean = 7.65		
Total	**110**	**100**
Farmers satisfaction with visit/contact		
Yes	79	71.8
No	31	28.2
Total	**110**	**100**

Access to Credit and Sources: the study found out that 70% of the respondents have access to credit facilities, and 30% have no access to credit. Accessibility to credit determines enhancement of the farmer's level of productivity (Ekong, 2003).

Sources of Credit: The study also revealed that 50% of the farmers obtained credit from commercial banks, 35% cooperative societies, family and friends 15% from community money lenders or others sources. The result was contrary with the findings of Ojo (2009) which reported that Bank had the least of 9% of the respondents, and 81% of the respondent reported cooperative societies as there source of credit.

Table 4.6: Distribution of the Respondent Base on Sources and Access to Credit Facilities

Variable	Frequency	Percentage (%)
Access to Credit		
Yes	77	70
No	33	30
Total	**110**	**100**
Sources of Credit (n = 77)		
Commercial Banks	38	50
Cooperative Society	15	19
Family/Friend	12	16
Community Money Lenders	4	5
Government Financial Institute	8	10
Total	**77**	**100**

Amount of Credit Obtained by Respondent: It was found that 36.4% of the respondents obtained ₦ 120,000- 250,000 for financing their NERICA rice farm, while

24.24% obtained ₦ 260,000-300,000.00 and 39.4% of the respondent obtained more than ₦ 310,000. The finding shows that 84% repaid their loan, 14% of the respondents reported crop failure at the time of the study is the reason for non-repayment, and 16.4% of the respondents not repay their loans.

Table 4.7: Distribution and statistic of Amount of Credit Obtained by Respondent

Variable	Frequency	Percentage (%)
Credit Obtained (₦)		
Non Respondent	54	45
120,000-250,000	24	22
260,000-300,000	16	15
310,000 and above	26	23
Total	**110**	**100**
Loan Repayment		
Yes	92	84
No	18	16
Total	**110**	**100**

Farm Size: The result from the study showed that average farm size is 3.6ha. The findings also shows that 66.4% of the respondents possessed 0.5-3ha were 22% of the participant farmers had 3.5 to 6ha this research indicated that rice production is dominated by small holders farmers, the inter mediate and large scale farmers represent only 12%. Farm size arrangement may influence the extent to which a given crop could be cultivated, in view of the problem posed by supply of land in Nigeria agriculture. This arrangement is expected to affect technology adoption positively.

Table 4.8: Total Farm size and size of farm for NERICA rice production

Variable	Frequency	Percentage
Total Farm Size (ha)		
0.5-3	73	66.4
3.5-6	24	21.8
6.5-9	6	5.5
9.5->	7	6.4
Mean = 3.66		
Total	**110**	**100**
Farm Size for NERICA Rice (ha)		
0.5-3	84	76.4
3.5-6	24	21.8
6.5->	2	1.8
Mean = 2.320		
Total	**110**	**100**

4.2 Rate of Adoption of NERICA Rice Agronomic Practices

Nevertheless, on the rate of adoption of NERICA agronomic practices in the area under investigation analysis have shown slight changes on the average rate of all the recommendations per variable. Findings indicated that 76% of the respondent adopted the agronomic practices for selected site appropriate for NERICA production in the study area. The study also revealed that the compliance scores are high for high yielding varieties adopted by the farmers 93% of the participant farmers agreed that the dominant reason for adoption of improved varieties were availability and awareness on it through the extension agents. The finding reported that 44% of the respondents adopted manual

threshing and harvest, 51% of the respondent adopted; seed rate and spacing and weed control 63% of the respondent. These dis-agree with survey shows that the adoptions of agrochemical that is pre-emergence and post-emergence herbicides were good alternatives to inadequate availability of manual labour especially at the busiest farming calendar. The study reported that 65% of the respondent adopted fertilizer over in-organic manure. This result in line with findings that scores recorded that fertilizer user's rate 65% of the respondent, Fertilizer has been known to account for more than 50% reduction in yield when not applied. The zero score for machinery threshing indicates the non-availability of machinery threshers to the farming households. Almost all the farming household planted rice as sole crop in the study area and this is one of the recommendations required for the realization of the full potential of wetland rice production technology.

Figure 4.1 Shows rise and fall pattern of the rate of adoption of the NERICA rice agronomic practices the implication for this is that the respondents adopt the NERICA agronomic practice in certain time and drop some in another time, this has been done to many factors such as government policies, pest and diseases damage and changes of price of NERICA rice.

Table 4.9: Distribution and Statistic of Respondent Based on Adoption of NERICA Rice Agronomic Practices

Agronomic Practices	**Frequency**	**Adoption Rate (%)**
NERICA Site Selection	84	76
NERICA Varieties	102	93
NERICA Sowing Time	72	65
Spacing and Seed Rate	56	51
Fertilizer	72	65
Weed Control	69	63
NERICA Harvesting	48	44
	503*	

*Number greater than n=110 due to multiple responses.

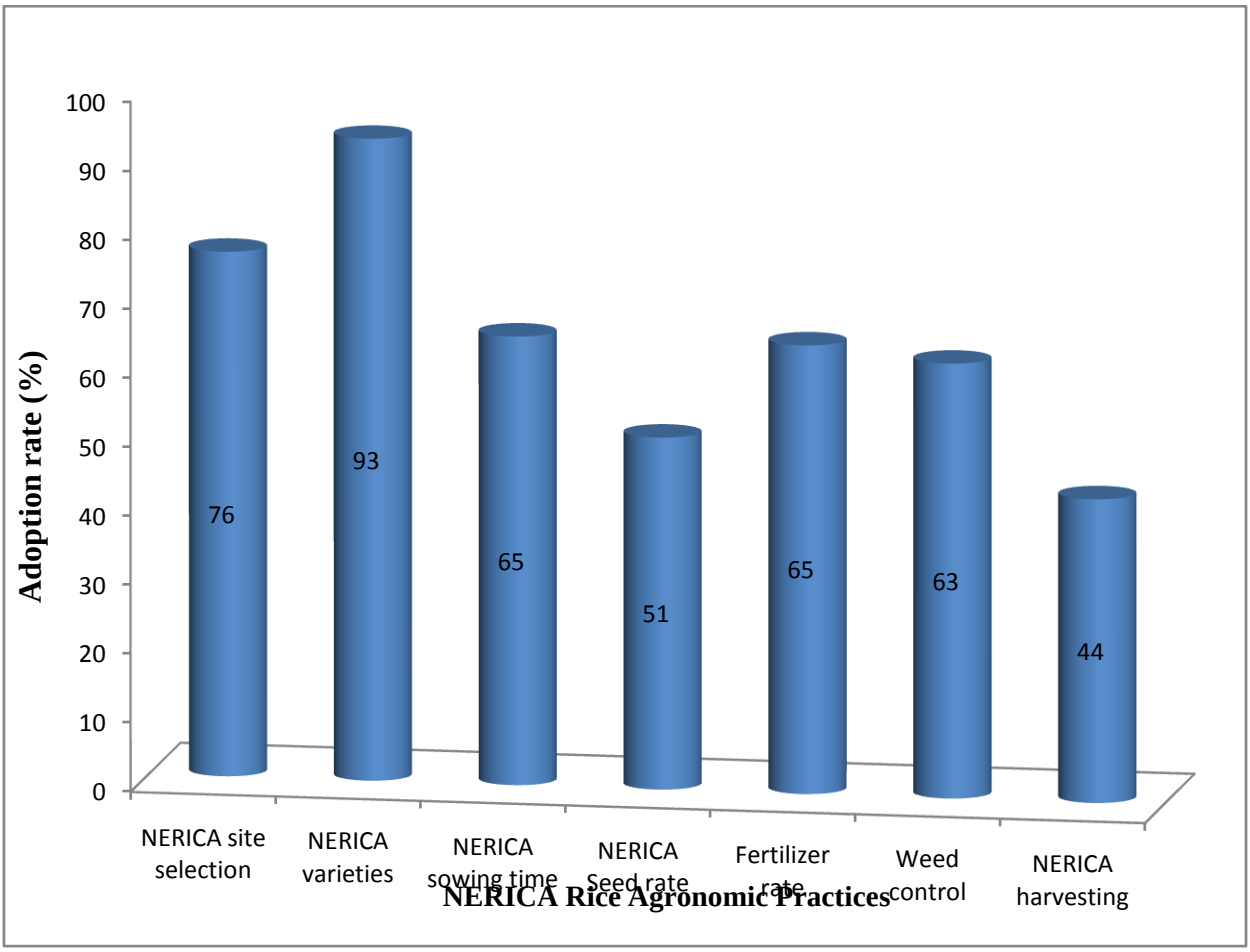


Figure 4.1: Average rate (%) of Adoption of the NERICA Rice Agronomic Practices by the Respondents.

4.3 Factors that Influencing Adoption of NERICA Rice Agronomic Practices

Result revealed that the factors influencing adoption of NERICA agronomic practices are age, level of education, farming experience, access to credit facilities, family size, and contact with extension agents and innovations characteristic that is affordability,. Extension contact has a positive influence on rice farmers' adoption to NERICA agronomic practices. Agricultural Development Projects (ADP) which is the extension unit of the State Ministry of Agriculture is the formal channel of contact with the farmers in Nigeria and study areas in particular; it is also the formal channel of diffusion of agricultural modernity. It is the organ responsible for contacting and organizing the farmers for the extension activities.

Table 4.10: Distribution and Statistic of Multiple Regression Results of Selected Socio-economic Characteristics and technological attributes that influence the adaptation of NERICA Rice Agronomic Practices

Variable	**Coefficient**	**Standard Error**	**T- value of T-value**	**Level of Significant**
Adoption (constant)	13.585	2.867	4.739	***
Age of farmers (X_1)	0.111	.047	-2.347	**
Level of education (X_2)	-.041	.426	-.123	NS
Farming Experience (X_3)	0.304	.089	3.411	***
Household size (X_4)	.038	.057	.660	NS
Farm Size (X_5)	2.220	.722	3.074	***
Extension Contact (X_6)	.506	.271	1.865	*
Access to Credit (X_7)	.447	.330	1.352	NS
Years of Association (X_8)	.138	.080	1.728	*
Affordability (X_9)	1.168	.822	.170	NS
Compatibility (X_{10})	.101	.058	1.756	*
Complexity (X_{11})	-102	.656	-.156	NS

R-square = 58%
Adjusted R-Square = .46%
F-Value = 50%
******* Coefficients statistically significant at 1% level
** Coefficients statistically significant at 5% level
* Coefficients statistically Significant at 10% level
NS = Not Significant

Socio-economic Characteristics: The study posited positive relationship between age of the farmers, level of education, farming experience, Household size, farm size, credit facilities, Extension intervention and farmer years of the association. The most significant determinants factors influencing marginal contributions to adoption NERICA rice agronomic practice are level of education (-0.041) significant at 5% level and household size (0.038) significant at 1% level. The coefficients of these two variables are negative but significant. This means that farmers with informal education and farmers with small family size seek to be adapting to NERICA agronomic practices. The farmers with small family size require more hired labour which will increase cost of production particularly for weed operation which is problem in upland rice farming. NERICA is expected to suppress weed growth and expected to reduce labour on weeding operation therefore farmers with small family size will be interested in a NERICA rice variety that will reduce labour requirement. The reason why there was inverse relationship between education and adoption may be because of the requirement for other factors that influencing to NERICA was not complex; all it entailed was to visit the extension agent.

The regression coefficient of the age of the farmers of the adoption of NERICA rice agronomic practice (0.111) was statistically significant at 5% level while the farming experience (0.304) was significantly at 1% level were the coefficient of farm size (2.220) was significantly at 1% level this result shows strong relationship between these variables and adoption and it's also indicated that the more the farmers level of farming experience and farm size the more the farmers adoption of NERICA rice agronomic practice the finding further reported that the regression coefficient of extension contact

(0.506) was statistically significant at 10% level this result revealed weak relationship between extension contact and rate of adoption of NERICA rice agronomic practices.

Technological Variable: The amount of time spent on completing an adoption stage is a function of the nature of the agronomic practice or technology itself. Roger and Shoemakers (1971), summary of perception on attributes of a technology by members of a social systems showed that they related to adoption. It is therefore crucial to carry out investigation on technological variables influencing the respondent's adoption behavior. Technological variables such Affordability, compatibility and complexity index were considered.

The regression coefficient of the adoption of NERICA rice agronomic practices of the technological affordability (1.168) was statistically not significant. Furthermore this investigation revealed that compatibility index variable considered as the degree to which the agronomic practice meet the needs of the potential adopters. It is of course obvious that a high degree of compatibility of technologies as adopts by the respondents, the high the level of adoption. The regression coefficient of the adoption of NERICA rice agronomic practice of compatibility index is low (0.101) was statistically significant at 10% level as found in this study, may imply a weak compatibility index was indicative of low relative advantage. It can then be inferred that compatibility index as a factor influencing the respondents to adopt the NERICA agronomic practice was low. This is contrary to the findings discovered that compatibility has a strong influence on adoption of improved rice varieties among women farmers in Oyo State.

Complexity index another variable equally considered in this category was complexity of the agronomic practice; it is difficult to use the agronomic practice while the practices

is too technical and the level of skill required to use is too high. The result obtained revealed that the regression coefficient of the adoption rate of the NERICA rice agronomic practices of the complexity (-102) was not significant.

4.4 Effect of Adoption of NERICA Rice Agronomic Practice on Yield, Income and Level of Living

4.4.1 Effect of adoption of NERICA rice agronomic practice on yield

Table 4.11 shows that 13% of the respondents reported 01-500kg/ha as increase obtained in yield while 22% indicated that 501-800/kg/ha increase obtained, 801-1200.00kg/ha increase reported by 8% while 42% of the participant farmers revealed greater than 1200kg/ha as the increased obtained as a result of growing NERICA Rice compared to tradition rice variety. The study agreed with findings of Kijima *et al*, (2006); Kijima *et al* (2008) and Lodin, (2006) their survey reported that the average increase in yield of NERICA in Uganda was found to be 2.2 tons per hectare, which is twice as large as the average yield of traditional rice in sub-Saharan Africa.

4.4.2 Effect of adoption of NERICA rice agronomic practice on income

The impact of NERICA varieties adoption on household income, are also documented in few studies which find generally NERICA to increase household income and to contribute to better income distribution within African rice growers households. Table 12 shows that 39% of the respondent indicated less than ₦10,000 as their income increase as a result of adoption of NERICA Rice agronomic practices while ₦ 11,000-20,000 realized by 17.82% of the respondent were ₦ 21,000-30,000 increase reported by 21.78% of the sampling population, this survey find out that ₦ 31,000-400,000 and greater than ₦41,000 reported by the 7.92% and 13.86% of the participant farmers as

the income increase they obtained as a result of increase in yield in their NERICA rice farm.

Kijima *et al.* (2008) analysis of impact on income and poverty showed that in Uganda, NERICA has the potential to increase per capita income by 20 USD (12% of actual per capita income) and to decrease the poverty incidence, measured by the head count ratio, by 5 percentage points (from 54.3% to 49.1%). This authors also found that, not only the head count ratios but also poverty gap index and squared poverty gap index decline by the introduction of NERICA, suggesting that its income enhancement can be realized among the poorest of the poor in this country of Eastern Africa.

In West Africa, Glove (2009), Dibba *et al*, (2010) and Dibba (2010) found NERICA adoption to have positive impact on household rice and total incomes in Gambia. In particular, Dibba (2010) found that adoption of NERICA increases the rice farmer's daily income by about 10 Dalasi approximately 0.34 USD on average. For Benin, Sogbossi (2008) identified NERICA adoption as a key determinant in poverty reduction and found that NERICA adoption contributed at 13% decrease in the probability of being poor. In addition, the gender-based analysis demonstrated that the impact of NERICA adoption is higher on women farmer (reduction of probability of being poor is 19%) than men (reduction of probability of being poor is 6%). Findings from another study conducted in Nigeria indicated that adoption of NERICA increased total farm household income and per capita expenditures by respectively ₦63, 771.94 approximately 554.5 USD and ₦ 4, 739.96 approximately 41.2 USD, thereby increasing their probability of escaping poverty (Dontsop *et al*, 2010).

Table 4.11: Analysis of Effect of Adoption on Yield, Income and Level of Living

Yield (kg/ha)	Frequency	Percentage	Mean
01-500.00	14	13.9	
501-800	22	21.8	
801-1200.00	8	7.9	
1201-1600.00	9	8.9	
1601-2000.00	6	5	
2000 and above	42	41.6	2363.56
Total	**110**	**100**	
Increase of Income (₦)			
Less than 10,000	39	38.6	
11,000-20,000	18	17.8	
21,000-30,000	22	21.8	
31,000-40,000	8	7.9	
Greater than 41,000-00	14	13.9	24079.12
Total	**110**	**100**	
Level of Living (Asset Value/=₦)			
100,000-200,000	24	21.8	
201000-300,000	14	13.9	
301000-400,000	18	16.4	
401000-500,000	13	11.8	
Greater than 501000	32	29.1	498816.04
Total	**101**	**100**	

4.4.3 Effect of adoption of NERICA rice on farmer's level of living:

The result in Table 4.12 revealed that 22% of the respondents reported ₦ 100,000-200,000 as their annual gain while 14% of the respondents had ₦201,000-300,000 at time of this study, 16% and 12% of the respondents obtained ₦301,000-500,000.00. The findings revealed that 29% of the respondents reported greater than 501,000.00 as their gain from sale of NERICA rice. The money was used by 16% of the respondent to improve family health, while 24% of the farmers spend their incomes for education,

13% of the respondents purchased pieces of land, while 16% had means of transport such as bicycle, motorcycle and many others. It was in line with findings of Glove (2009) who revealed that 22% of the rice farmers in the six districts surveyed in Uganda, said rice farming has helped in the education of their children through being able to pay school fees and provide basic educational requirements for the children, while 17% and 12% of the farmers respectively reported that the money obtained from sale of rice was used to purchased house equipment and essentials for enhancing household food security. The other benefits included improvements in shelter (10%), clothing and bedding (8%), as well as buying food (7%), expanding farmland (5%), paying medical bills (5%), acquiring improved means of transportation, recreation and entertainment, hiring farm labour and boosting income generating businesses.

Hypotheses Testing:

Multiple regression analyses of socio-economic, institutional, technology variables and rate of adoption of NERICA rice agronomic practices.

Attempt was made to show the influence made by the independent variables (socio-economic, institutional; and technological attribute) on the dependent variables (adoption, yield and income). This was achieved by the use of multiple regression analysis.

Hypothesis 1:

It was hypothesized that there is no significant relationship between socio-economic characteristic of NERICA rice farmers to adoption of NERICA rice agronomic practices. The influence of the socio-economic characteristics of the respondent such as age, level of education family size, farming experience farm size, extension contact, membership of the association and access to credit facilities on the adoption of NERICA

agronomic practices was conducted, the ordinary lease square model was used to determine functional relationship of the variables.

Table 4.12 shows that the overalls contribution of the socio-economic variable such as extension contact, level of education, farm size, age, sex, marital status and family size to the variation in the rate of adoption was 46% (Adjusted R^2). The Table further revealed that the most significant factors influencing adoption of NERICA rice are level of education (-0.041), significant at 5% level, family size (0.038) significant at 1% level. The coefficients of these two variables are negative but have significant influence on the adoption of NERICA agronomic practices. This means that farmers with informal education and small family size seek to be adopting to NERICA agronomic practices. This study agrees with findings reported significant relationship between education and adoption. Similarly, Lindner *et al*.; (1982) discovered significant relationship between education, family size and adoption respectively. The farmers with small family size require more hired labour which will increase cost of production particularly for weed operation which is problem in upland rice farming. NERICA rice suppressed weed growth and expected to reduce labour on weeding operation therefore farmers with small family size will be interested in a NERICA rice variety that will reduce labour requirement. The reason why there was inverse relationship between education and adoption may be because of the requirements for cultivations NERICA were not complex; all it entailed was to visit the extension agent. The regression coefficient of age was -111 significant at 5% level while the farming experience was 0.304 significant at 1% level the coefficient of farm size was 2.220 significantly at 1% level. This result shows strong relationship between these variables and adoption and it is also indicated that the more the farmers level of farming experience and farm size the more the

farmer's adoption of NERICA rice agronomic practice. The finding further reported that the regression coefficient of extension contact (0.506) was significant at 10% level this result revealed weak relationship between extension contact and rate of adoption of NERICA rice agronomic practices. The weak relationship has been attributed to low level of extension contacts found in the study area. It was in line with Atala (1984) who confirmed independently the important role of extension agent in the diffusion and adoption of an innovation.

Hypothesis Two

It was hypothesized that there is no significant relationship between influence of adoption of NERICA rice agronomic practices and yield, income and level of living of the NERICA rice farmers in the study areas, in Table 4.13 the level of significant between adoption and variables income, yield and level of living shows that the income significant level was $P<0.01$ which indicated strong relationship between farmers income and adoption level, while there was no significant relationship observed between adoption and level of living significantly correlated at $P<0.05$ this have negative correlation with weak influence of the adoption of NERICA agronomic practices. This study was contrary to the findings of Dalton (2004) who discovered that yield as a significant variable positively influencing the adoption of recommended practices. This implies that adoption increase considerably with increase in yield and income. The null hypotheses which stated that there is no significant influence between NERICA rice agronomic practices adoption on yield and income respectively are therefore accepted. Furthermore the investigation revealed that farmers level of living was significantly correlated with level of $P<0.01$ that is $P<0.05$ the influence of level of living to adoption

correlation significant level is very high this is contrary to what the hypotheses of the study stated therefore null hypotheses rejected.

Table 4.12: Pearson Product Monument Correlation Show the relationship Between the Adoption of the NERICA Rice and Yield Income and Farmers Level of Living

	Yield	Income	Level of living	Adoption
Yield	1			
Income	0.715**	1		
Level of Living	0.044	0.224*	1	
Adoption	0.109	0.046	-0.107	1

** Correlation is Significant at the 0.01 level (1-tailed).

*Correlation is Significant at the 0.05 level (tailed)

4.5 The constraints Encountered by Farmers in the Adoption of NERICA Rice Agronomic Practices

One of the specific objectives of this study was to identify the constraint limiting the adoption of NERICA Rice in the study area were the farmers asked to freely identify those factors they considered to be constraints to their NERICA rice production as presented in Table 4.13. The Table also indicated that the higher cost of Fertilizer represent 52.7% rank's first among the list of constraints. 47.3% of the respondents revealed that lack of capital ranks second followed by poor credit facilities to finance their NERICA Rice farm the result show's that farmers sources internal fund from their personal saving in addition to credit. According to participant's farmers 33.6% and 10% respectively, reported inadequate extension services and manpower as the serious challenges facing the adoption of NERICA Rice agronomic practices. Agro-chemicals such as herbicides, seed treatment chemicals, insecticides and pesticides revealed by 16.4% of the participant farmers as a constraints ranking seven and least for limitation of the adoption of NERICA agronomic practice. However, the constraint which has not

been adequately addressed according to farmers is that of road for transportation linking from farm site to the market.

Table 4.13: Distribution of Respondents Base on Constraints to Adoption of the NERICA Rice Agronomic Practices

Constraints	**Frequency**	**Percentage**	**Rank**
High cost of fertilizer	58	52.7	1st
Lack of capital	52	47.3	2nd
Poor credit facilities	41	37.3	3rd
Inadequate extension	37	33.6	4th
Lack of storage facilities	29	26.4	5th
Inadequate seeds	20	18.2	6th
High cost of agrochemicals	18	16.4	7th
Inadequate manpower	11	10.0	8th
	266*		

*Multiple responses

CHAPTER FIVE

SUMMARY, CONCLUTION AND RECOMMENDATIONS

5.1 Summary

This adoption study was conducted to evaluate the factors influencing the adoption of NERICA rice agronomic practices among farmers in three selected Local Government Areas (LGAS) of Kano State, Nigeria. The specific objectives were to: identify the socio-economic characteristics of NERICA rice farmers; determine the rate of adoption of NERICA agronomic practices adopted by farmers; determine factors influencing adoption of NERICA agronomic practices, determine the relationship between adoption of NERICA Rice agronomic practices and yield, income and level of living of the farmers, identify the constraints encountered by the farmers in adoption of NERICA rice agronomic practices. Despite the introduction of NERICA rice varieties, there is still insufficient empirical information showing that farmers have adopted NERICA rice agronomic practices it is against this backdrop this study was carried out in the study areas.

The study areas were: Tudun wada, Garin Malam, and Kura these three Local Government Areas are located in the south west of Kano state, between latitudes $11^{0}15^{1}$ N and Longitudes $8^{0}25$E. Annual rainfall ranges 600-1200mm and temperatures between 30-35◦c. A multistage sampling method was employed: Firstly, three LGAs with highest level of NERICA rice production were selected; Secondly two villages on the basis of being the most prominent NERICA rice producing areas from each LGA were selected. Thirdly From a sample frame of 548 farmers 20% were selected giving sum of 110 NERICA farmers was used for this study. The main instrument for primary data collection was structured questionnaire administered to the sampled NERICA

farmers in the study area with the help of trained enumerators. Descriptive Statistics was used to achieve objectives i, ii, and v. Multiple Regression Analysis was used to test the hypotheses i and to achieve objective iii. Pearson's product moment Correlation Analysis was used to achieve objective iv and to test the hypothesis ii.

It was found that majority of the respondent 96% are male with an average age of 36-40 and 92% married were 8% are single, this implying that majority of the respondents were married. The study revealed that 93% of the respondent adopted NERICA varieties, 44% of the respondent adopted manual threshed, were seed rate and spacing adopt by 51% while weed control adopted by 63%. Result revealed that the Level of education, age, family size, extension contact, farming experience, access to credit facilities, membership of the association, affordability, complexity, compatibility were the most significant factors influence adoption of NERICA rice agronomic practices. The other significant determinants of exposure with significant marginal contributions to NERICA rice agronomic practices adoption are level of education (- 0.024) significant at 5% level and family size (-0.002) significant at 1% level. The coefficients of these two variables are negative but significant. This means that farmers with informal education and farmers with small family size seen to be adopted NERICA. It was found that there were 39% indicated less than ₦1000-10,000 income increase as a result of adoption of NERICA Rice agronomic practices while ₦ 11,000-20,000 realized by 18% of the respondent were ₦ 21,000-30,000 increase reported by 22%. The survey found that there were ₦31,000-400,000 and ₦ >41,000 gained by 8% and 14% as income increase respectively as a result of increase in yield in their NERICA rice farm. It was found that 53% of the farmers reported higher cost of Fertilizer, 47.3% poor credit

facilities, 34% inadequate extension services, 16.4% reported insufficient agrochemicals.

5.2 Conclusion

This study provides empirical information on the possibilities of enhancing productivity gains in upland and lowland rice through promotion and adoption of NERICA rice agronomic practices. Results showed that adoption of NERICA agronomic practices had made an appreciable effect of 49% on farmers yield, even though traditional methods of rice cultivation are still predominant among rice farmers. Farmer's socio-economic characteristics like level of education, extension contact, farming experience, household size, credit facilities and innovations characteristic like affordability, comportability and complexity affected collectively contribute 46% to the variability in the adoption of NERICA rice agronomic practices. It is therefore concluded that promotion of NERICA rice production is a worthwhile effort.

The findings in this study indicated that adoption of improved varieties helped raise farmers' income by 39%, thereby increasing their probability of escaping poverty. This confirmed the widely held view that productivity-enhancing agricultural innovations can contribute to raising incomes of households. However, it is noteworthy to mention that the results from this study showed that farmers in the state generally continue to use the traditional rice varieties alongside the improved ones, although complementary measures are needed to improve technological requirements for changing farming practices.

5. 3 Contributions to Knowledge

i. About 76% of the respondents adopted site selection for NERICA production, 63%, 51% and 44% adopted seed rate and spacing, weeds control and manual threshing and harvesting respectively

ii. Farming experience, farm size, extension contact, years in association and technology comportability were the factors significantly influencing adoption by 46% (Adjusted R-square).

iii. NERICA adoption by farmers increased their yield by 72%, income by 56% and farmers level of living by 69%.

iv. The major constraint encountered in adoption of NERICA rice include high cost of fertilizer reported by (53%) of the respondents and lack of capital (81%).

5.4 Recommendations

Based on the findings of this study the following recommendations have been made:

i. It was found that majority of the respondents joined cooperative societies. This facilitated access to vital information and credit facilities for NERICA rice production. Therefore it was recommended that farmers should be encouraged to joint cooperatives for easy access to agricultural information and credit facilities.

ii. The study found that majority (93%) of the respondents adopted varieties of NERICA rice in the study areas. The Extension workers should intensify their effort by giving farmers training and advisory services toward modification in management practices such as choosing crop varieties

.

iii. Adoption of NERICA rice agronomic practices was found to have significant effects on yield, income and level of living of the respondents. Based on this success it is hereby recommended that the NERICA rice production should be scaled up and replicated in other Local Government Areas within the State.

iv. It was found that the farmers still used traditional method of rice production which resulted in low yield in the study area. Therefore, for full adoption, extension agents should increase their level of contacts and use better medium of communication.

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QUESTIONNAIRE
QUESTIONNAIRE FOR RICE NERICA FARMERS
Department of Agricultural Economics and Rural Sociology,
Ahmadu Bello University, Zaria

Dear Sir/Madam,

I am a postgraduate student in the Department of Agricultural Economics and Rural Sociology of Ahmadu Bello University Zaria, currently researching on the following topic: **"Factors Influencing Adoption of NERICA Rice Agronomic Practices among Farmers in Three Selected Local Government Areas of Kano State".** Please answer the questions to the best of your knowledge. All information supplied will be treated with confidentiality.

Thank You

SECTION A: Background Information

1. Name of respondent: ……
2. Name of village: ……
3. Name of LGA: ……..…….

Section B: Socio-economic Characteristics of NERICA Rice Farmers:

4. Age:…… ……years
5. Sex: Male ( ) Female ( )
6. Marital Status: Married ( ) Single ( )
7. How many wives do you have? .....
8. (a) How many children do you have? .....

(b) How many are staying in your household now? .....

9. Beside your wife/wives and children, are there other people living with you?

Yes ( ) No ( )

10. If yes, how many of them? .....
11. Educational Qualification of Head of Household: Years

a. No formal education ( )
b. Adult education ( )
c. Koranic education ( )

d. Primary education ( )

e. Secondary education ( )

f. Tertiary education ( )

12. How long have you been in NERICA Rice farming ( )

13. Do you belong to any social organization? Yes ( ) No ( )

14. If yes, how many social organizations do you now belong to? .....

15. If yes, for how long have you been in?.....Years

16. (a) Did you have any visit by extension agents since year 2012? Yes ( ) No ( )

(b) If yes, how many times were you visited by the extension agents with information on NERICA Rice Agronomical practices from the year 2012 farming seasons?.....Times

(c) How many times do you visit extension agent? .....Times

(d) Farmer –farmer contact……...…Times

17. (a) Are you satisfied with the extension visit? Yes ( ) No ( )

(b) If yes, give reasons……..……..

…….

(c) If no, give reasons……

……..

18. Do you have access to credit for NERICA Rice production? Yes ( ) No ( )

19. If No, how do you finance your NERICA Rice farm?

……

……

20. If yes, state sources and amount of credit received since year 2012.

S/No	Sources	Amount ₦
i		
ii		
iii		
iv		
v		

21. Did you repay the credit after harvesting your NERICA Rice? Yes ( ) No ( )

22. If No, please give reasons for non-repayment of the credit.

……

……

……

……..……

Section C: NERICA Rice Agronomic Practices Adopted by Farmers.

23. Which of the NERICA Rice agronomic practices have you adopted as introduced by Kano State Ministry of Agriculture?

S/NO	NERICA Rice Agronomic Practices	Yes	No	If yes, indicate the Year of first use
1.	NERICA Site selection: -upland -Lowland.			
2.	NERICA Varieties : -Early maturity NERICA1, 2, 3 and 4 -Medium maturity FARO 48, 49 and 53 -Late maturity FARO 25.			
3.	NERICA Sowing Time: -Savannah May-June.			
4.	Seed Rate: -Dibbling seed rate: 50- 60 kg/ha. -Drilling seed rate: 75- 80kg/ha. -Broadcasting: seed rate: 80- 100kg/ha.			
5.	Fertilizer: -Organic manure in form of compost -Inorganic (minerals) NPK15 - 15–15; NPK 20 – 10 – 10; NPK 30 - 10 – 0.			
6.	Weed Control: -Mechanical control -Chemical control			
7.	NERICA Harvesting: -Harvesting machine			

24. State reasons for using NERICA Rice agronomic practices indicated above:

a. ……..……..

b. ……...……..

c. ……...…..

d. …….

e. …….

f. …….

g. …….

25. State reasons for not using NERICA Rice agronomic practices below:

S/NO	NERICA Rice Production Agronomical Practices	Reason For Not /Continue Using
I	NERICA Site selection: -upland -Lowland.	
Ii	NERICA Varieties : -Early maturity NERICA1, 2, 3 and 4 -Medium maturity FARO 48, 49 and 53 -Late maturity FARO 25.	
Iii	*NERICA Sowing Time:* *-Savannah May-June.*	
Iv	Seed Rate: -Dibbling seed rate: 50- 60 kg/ha. -Drilling seed rate: 75- 80kg/ha. -Broadcasting: seed rate: 80- 100kg/ha.	
V	Fertilizer: -Organic manure in form of compost -Inorganic (minerals) NPK15 - 15–15; NPK 20 – 10 – 10; NPK 30 - 10 – 0.	
Vi	Weed Control: -Mechanical control -Chemical control	
Vii	NERICA Harvesting: -Harvesting machine	

Section E: Land Size and Source of Labour for NERICA Rice Agronomic Practices

33. How many hectares did you use for farming purpose in 2012? .....ha

34. What size of your farms did you use for NERICA Rice farming in year 2012? .. .ha

35. Did you have available labour for NERICA Rice farming in 2012? Yes ( ) No ( )

36. Did you use hired labour for NERICA Rice farming in 2012?Yes ( ) No ( )

37. If yes, how many people did you use for the following operations?

S/NO	Operations:	Male: 18yrs and above	Female: 18 years and above	Male: 12-17yrs	Female:12-17yrs
I	Land clearing				
Ii	Ridging				
Iii	Planting				
Iv	Weeding				
V	Fertilizer application				
Vi	Harvesting				
Vii	Total				

38. Did you use family labour for NERICA Rice farming in 2012? Yes ( ) No ( )

39. If yes, how many people from your family did you used for NERICA Rice farming?

S/NO	Operations for NERICA Rice	Male: 18yrs and above	Female: 18 years and above	Male: 12-17yrs	Female:12-17yrs
I	Land clearing				
Ii	Ridging				
Iii	Planting				
Iv	Weeding				
V	Fertilizer application				
Vi	Harvesting				

40. How much did you pay/5hrs/person in 2012 for the following categories of people?

a. Male: 18 years and above ₦ ……..

b. Female: 18 years and above ₦……

c. Male: 12 – 17 years₦…….....

d. Female: 12 – 17 years ₦…….

41. What was the quantity of NERICA Rice you harvested in 2012? .....(100kg)

42. What was the price (Naira) per……. 100kg of NERICA Rice in 2012?

43. Indicate the Property you Purchase with the money from selling NERICA Rice

S/N	Item	Quantity	Market value at Purchased Time	Current market value if to be sold ₦	Total value ₦
1.	Buses				
2.	Pick ups				
3.	Motor cycles				
4.	Bicycles				
5.	Donkeys				
6.	Horses				
7.	Cattles				
8.	Sheep				
9.	Goats				
10.	Ox-plough				
11.	Others Specify				

44. Is there any change in your NERICA Rice yield, Income Level and Level of Living as a result of adoption of NERICA Rice Agronomic practices?

S/NO	Expected outcome	Yes	No
I	NERICA Rice Yield		
Ii	Income Level		
Iii	Level of Standard Living		

45. If yes, how? Decrease or increase.

S/NO	Expected Outcome	Increase	Decrease
i	NERICA Rice Yield		
ii	Income Level		
iii	Level of Standard Living		

46. If increase, how did the increase influence change in the following?

S/NO	Expected Outcome	State How Increase Influenced Change
i	NERICA Rice Yield	
ii	Income Level	
iii	Level of Standard Living	

47. If Decrease, how did the decrease influence change in the following?

S/NO	Expected Outcome	Stated How Decrease Influenced Change
I	NERICA Yield	
Ii	Income Level	
Iii	Level of Standard Living	

Section F: The Constraints Encountered by Farmers in the Adoption of NERICA Rice

48. The following NERICA Rice Agronomic Practices are expensive (Affordability)

S/No	NERICA Rice Agronomic Practices	Agree	Undecided	Disagree
I	NERICA Site selection: -upland -Lowland.			
ii	NERICA Varieties : -Early maturity NERICA1, 2, 3 and 4 -Medium maturity FARO 48, 49 and 53 -Late maturity FARO 25.			
iii	NERICA Sowing Time: -Savannah May-June.			
vi	Seed Rate: -Dibbling seed rate: 50- 60 kg/ha. -Drilling seed rate: 75- 80kg/ha. -Broadcasting: seed rate: 80- 100kg/ha.			
v	Fertilizer: -Organic manure in form of compost -Inorganic (minerals) NPK15 - 15–15; NPK 20 – 10 – 10; NPK 30 - 10 – 0.			
vi	Weed Control: -Mechanical control -Chemical control			
vii	NERICA Harvesting: -Harvesting machine			

51. The following NERICA rice agronomical practices meet my need and existing values (Compatibility)

S/No	NERICA Rice Agronomic Practices	Agree	Undecided	Disagree
i.	NERICA Rice Site selection: -Upland -Lowland.			
ii.	NERICA Rice Varieties: -Early maturity NERICA1, 2, 3 and 4 -Medium maturity FARO 48, 48 and 53 -Late maturity FARO 25			
iii.	NERICA Sowing Time: -Savannah May-June.			
iv.	Seed Rate: -Dibbling seed rate: 50- 60 kg/ha. -Drilling seed rate: 75- 80kg/ha. -Broadcasting: seed rate: 80- 100kg/ha.			
v.	Fertilizer: -Organic manure in form of compost -Inorganic (minerals) NPK15 - 15–15; NPK 20 – 10 – 10; NPK 30 - 10 – 0.			
vi.	Weed Control: -Mechanical control -chemical control			
vii.	NERICA Rice Harvested: -Harvesting Machine.			

52. The following NERICA Rice Agronomic Practices is difficult to use: (Complexity)

S/No	NERICA Rice Agronomic Practices	Agree	Undecided	Disagree
i.	NERIC Rice Site selection: -Upland -Lowland.			
ii.	NERICA Rice Varieties: -Early maturity NERICA1, 2, 3 and 4 -Medium maturity FARO 48, 49 and 53 -Late maturity FARO 25.			
iii.	NERICA Rice Sowing Time: -Savannah May-June.			
iv.	Seed Rate: -Dibbling seed rate: 50- 60 kg/ha. -Drilling seed rate: 75- 80kg/ha. -Broadcasting: seed rate: 80- 100kg/ha.			
v.	Fertilizer: -Organic manure in form of compost -Inorganic (minerals) NPK15 - 15–15; NPK 20 – 10 – 10; NPK 30 - 10 – 0.			
vi.	Weed Control: -Mechanical control -chemical control			
vii.	NERICA Rice Harvesting: -Harvesting Machine			

53. Apart from the above, what other problems are you facing for the adoption of NERICA Rice Agronomic Practices in your area?

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54. What suggestions will you give to improve upon of using Agronomic practices?

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Thank you